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Kobayashi et al.

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(54) **EMBROIDERY FRAME AND SEWING MACHINE**

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D05C 9/06	(2006.01)
D05C 7/08	(2006.01)
D05B 19/12	(2006.01)
D05B 35/06	(2006.01)

(52) **U.S. Cl.**

CPC ***D05C 9/04*** (2013.01); ***D05B 19/12*** (2013.01); ***D05B 35/06*** (2013.01); ***D05C 7/08*** (2013.01); ***D05C 9/06*** (2013.01)

(58) **Field of Classification Search**

CPC D05C 7/00; D05C 7/02; D05C 7/08; D05C 11/00; D05C 9/04; D05C 9/06; D05C 3/02; D04D 1/04; D05D 2303/08; D05B 3/12; D05B 3/243; D05B 53/00; D05B 39/00; D05B 19/12; D05B 19/16; D05B 35/06

See application file for complete search history.

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(57) **ABSTRACT**

An embroidery frame includes a mounting portion, an annular portion, a rotation member, a first guide portion, an extending portion, and a drive mechanism. The mounting portion is mounted on a carriage of a sewing machine. The annular portion holds a work cloth. The rotation member is formed in an annular shape and is supported by the annular portion. The rotation member rotates in a circumference direction of the annular portion. The first guide portion is provided on the rotation member and has a first penetrating portion. A through hole is formed in the first penetrating portion. A string-like material to be supplied for sewing is inserted through the first penetrating portion. The extending portion is formed on the annular portion and extends toward the outside in a radial direction of the annular portion. The drive mechanism is provided on the extending portion and rotates the rotation member.

9 Claims, 15 Drawing Sheets

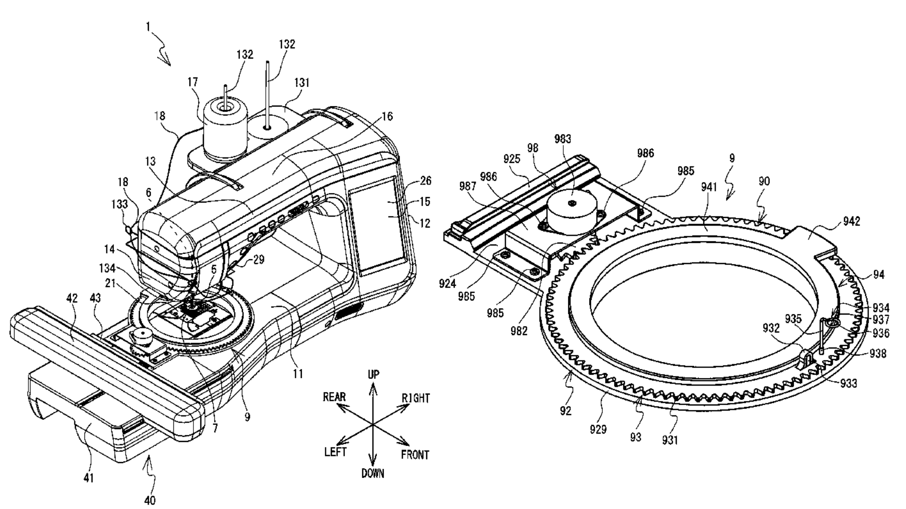

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FIG. 1

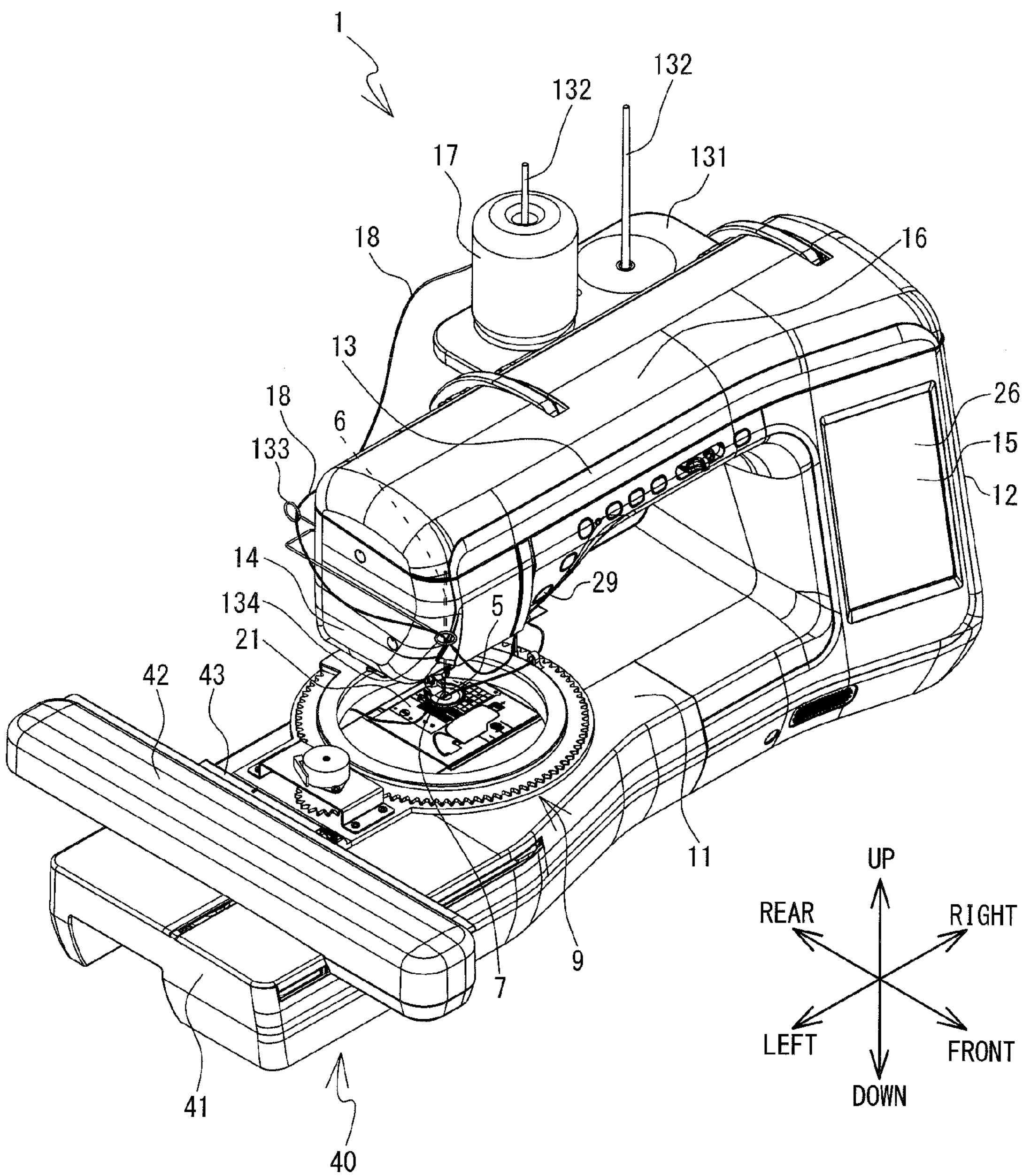
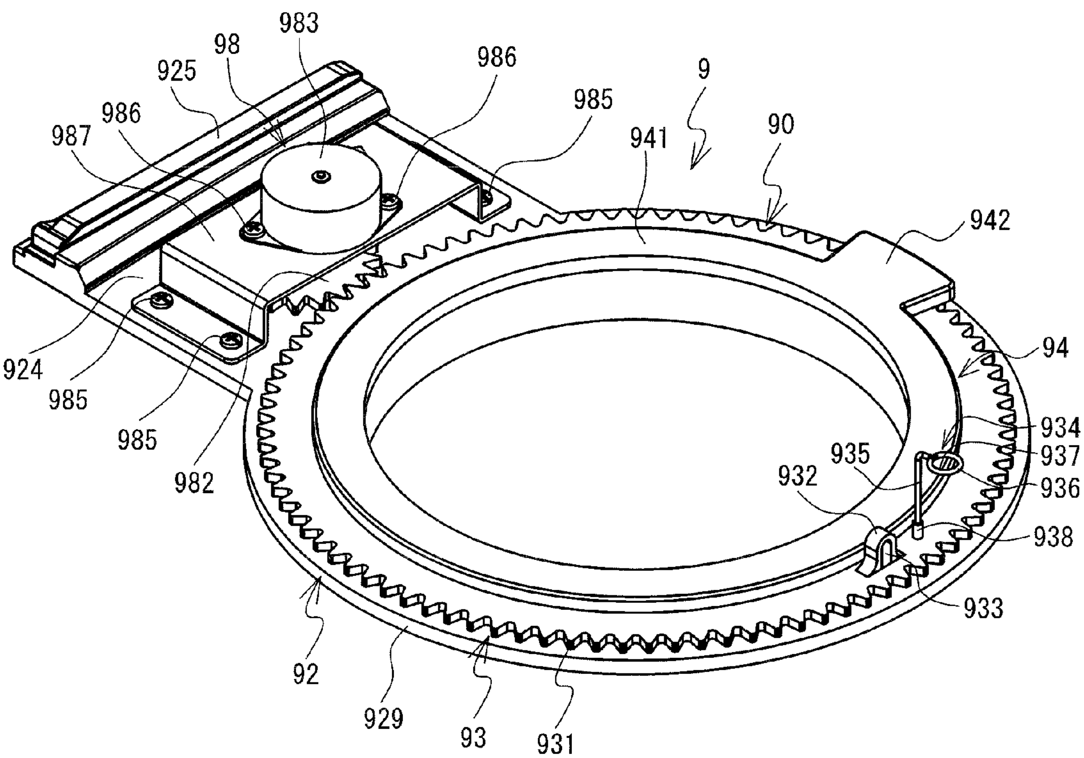

1
132
132
17
131
18
16
13
26
18
6
15
133
12
14
29
134
5
21
42
43
11
UP
REAR
RIGHT
9
7
LEFT
FRONT
DOWN
41
40

FIG. 2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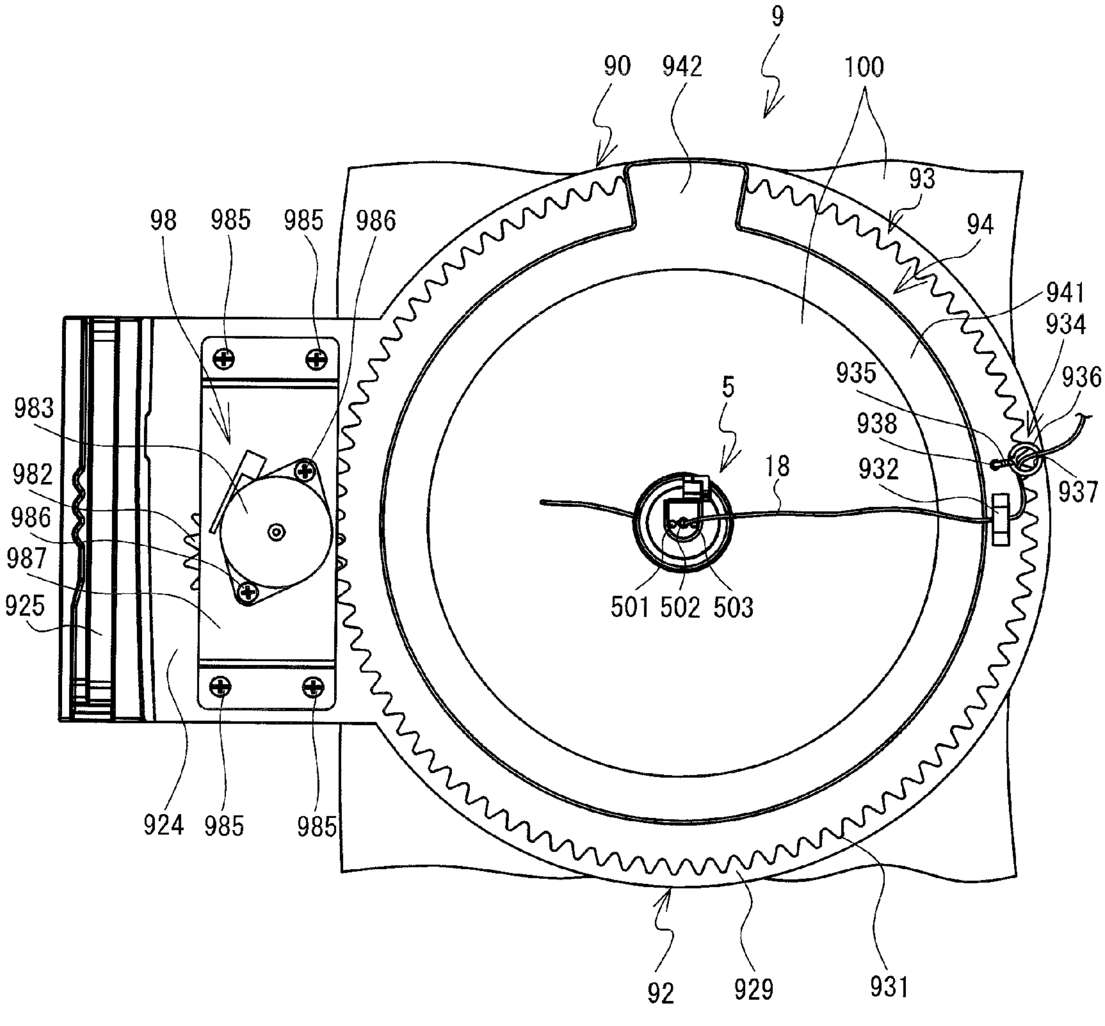
98
925
986
986
987
985
9
90
941
942
924
985
985
982
94
934
935
937
932
936
938
933
92
929
93
931

FIG. 3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90
942
100
93
94
941
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936
98
985
985
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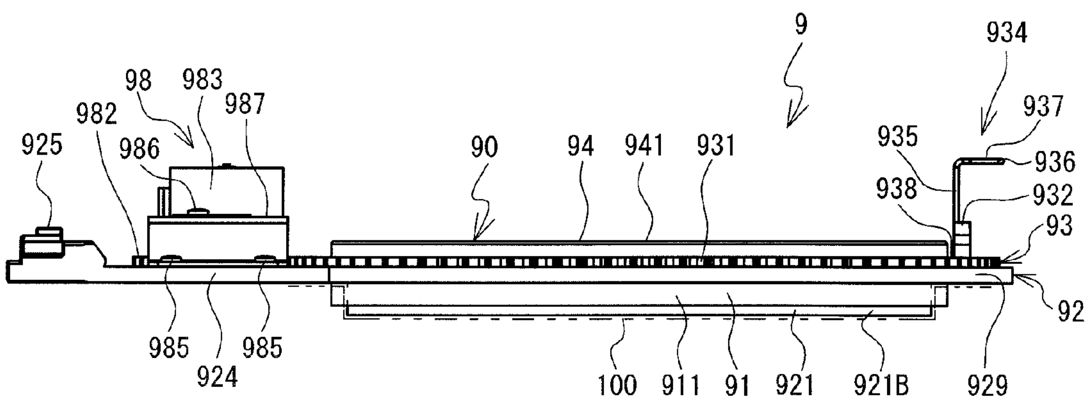
983
935
938
937
5
18
932
982
986
987
925
501
502
503
924
985
985
92
929
931

FIG. 4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92
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98
983
987
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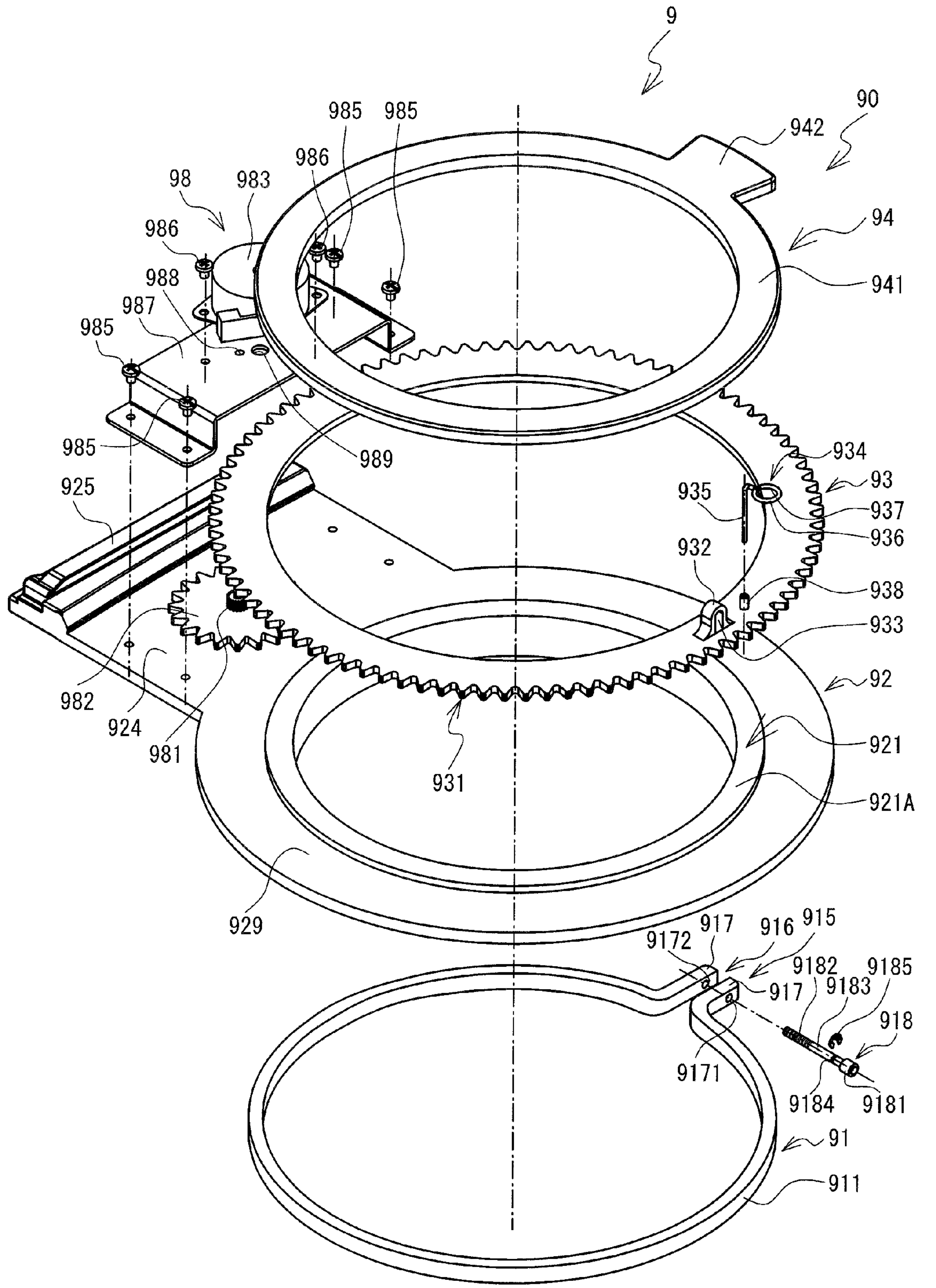
941
931
985
924
985
100
911
91
921
921B

FIG. 5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90
985
985
942
986
98
983
94
986
988
941
987
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989
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925
935
93
937
936
932
938
933
92
982
924
921
981
931
921A
929
917
916
915
9172
9182
9185
917
9183
918
9171
9184
9181
91
911

FIG. 6

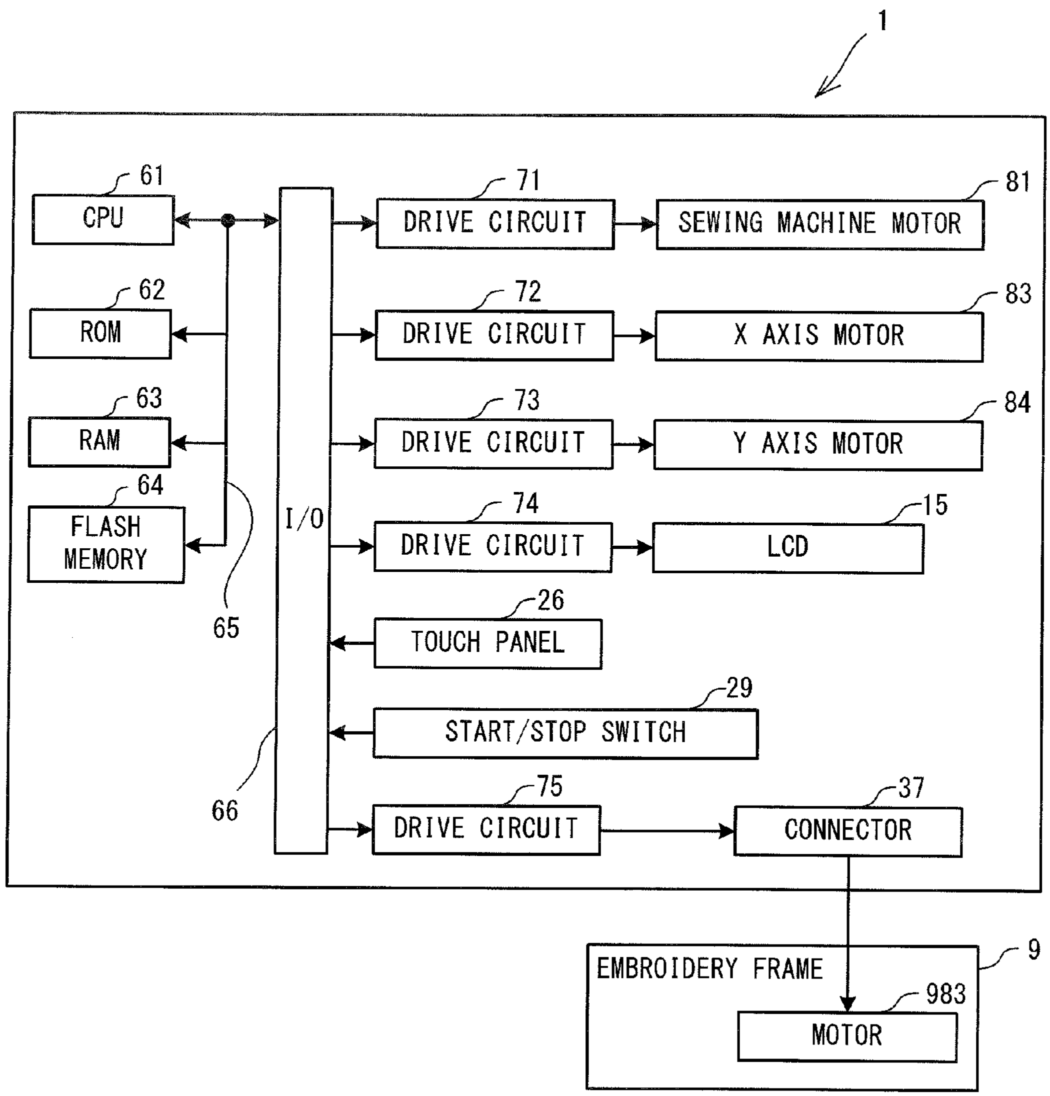

1
61
CPU
62
ROM
63
RAM
64
FLASH MEMORY
65
66
I/O
71
DRIVE CIRCUIT
81
SEWING MACHINE MOTOR
72
DRIVE CIRCUIT
83
X AXIS MOTOR
73
DRIVE CIRCUIT
84
Y AXIS MOTOR
74
DRIVE CIRCUIT
15
LCD
26
TOUCH PANEL
29
START/STOP SWITCH
75
DRIVE CIRCUIT
37
CONNECTOR
9
EMBROIDERY FRAME
983
MOTOR

FIG. 7

80

NUMBER OF STITCHES	X COORDINATE	Y COORDINATE	ROTATION ANGLE
1	1	−1	265 DEGREES
2	0	−1	265 DEGREES
3	−1	−1	265 DEGREES
4	−2	−1	265 DEGREES
5	−3	−1	265 DEGREES
6	−4	−1	265 DEGREES
7	−5	−1	265 DEGREES
8	−5	0	333 DEGREES
9	−5	1	333 DEGREES
10	−5	2	333 DEGREES
11	−5	3	333 DEGREES
12	−4	3	75 DEGREES
13	−3	3	75 DEGREES
14	−2	3	75 DEGREES
15	−1	3	75 DEGREES
16	0	3	75 DEGREES
17	1	3	75 DEGREES
18	1	2	175 DEGREES
19	1	1	175 DEGREES
20	1	0	175 DEGREES
21	1	−1	175 DEGREES

FIG. 8

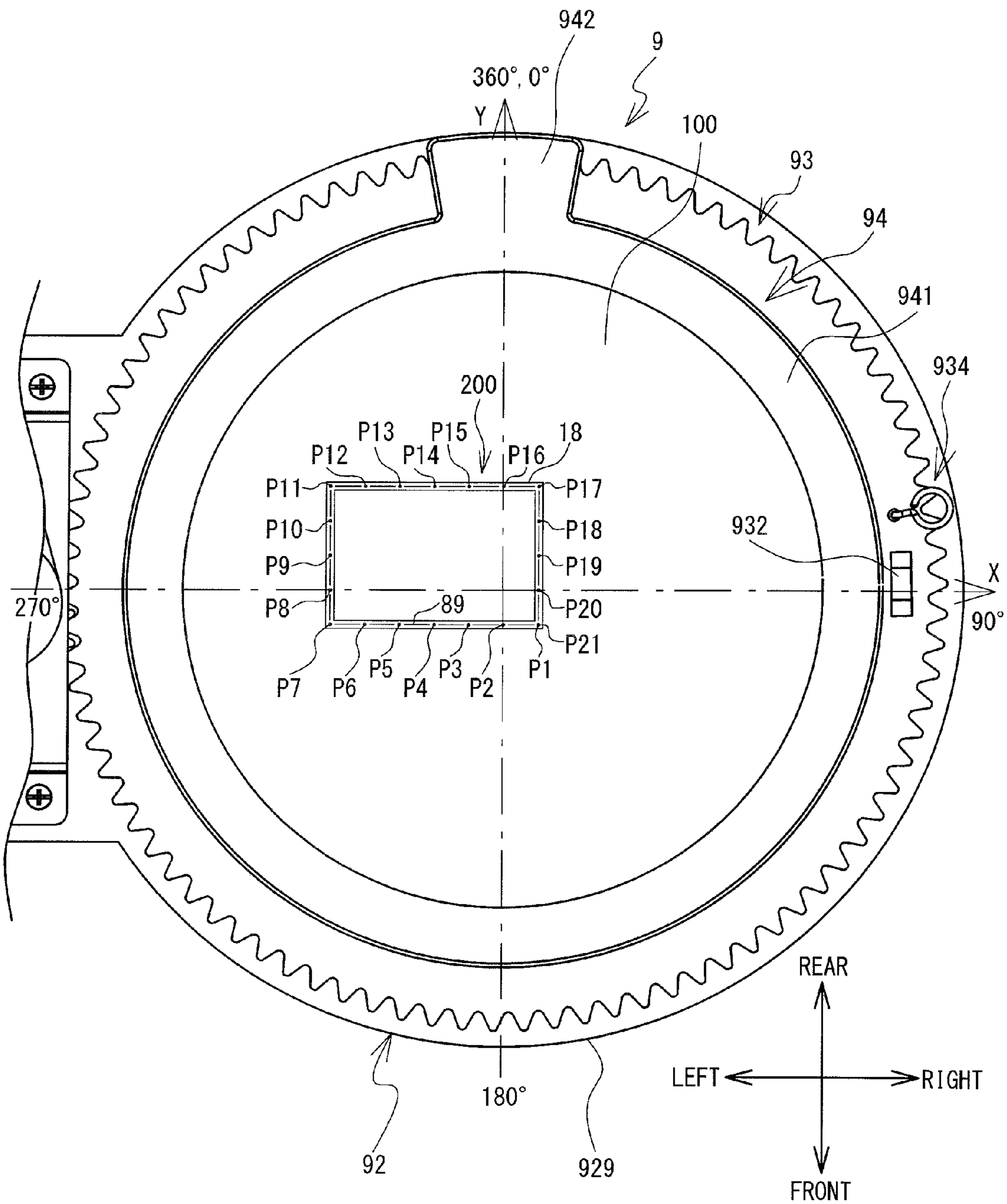

942
9
360°, 0°
Y
100
93
94
941
934
200
P13
P15
18
P12
P14
P16
P11
P17
P10
P18
P9
P19
932
X
270°
P8
89
P20
90°
P21
P7
P6
P5
P4
P3
P2
P1
REAR
LEFT
RIGHT
180°
92
929
FRONT

FIG. 9

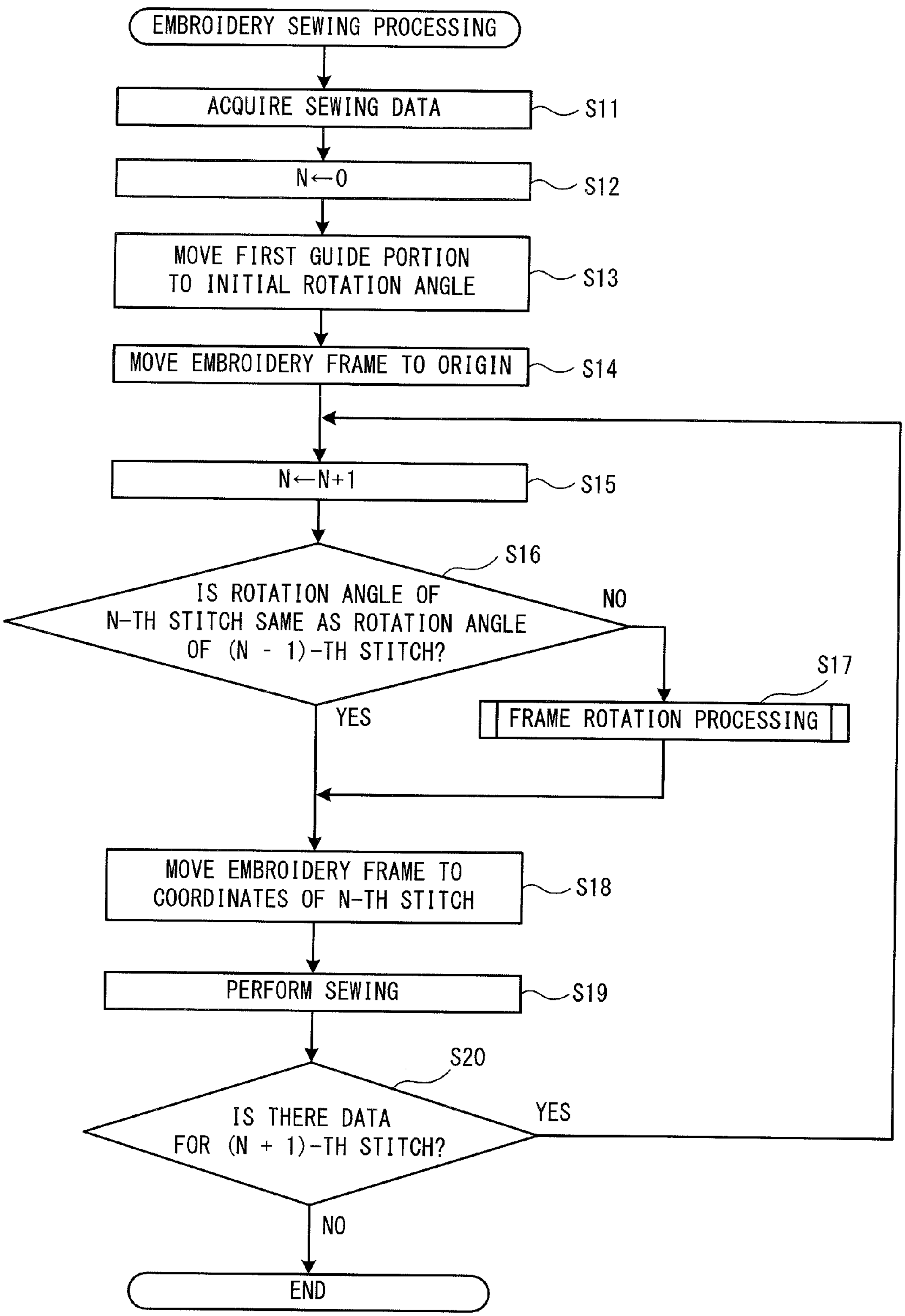

EMBROIDERY SEWING PROCESSING
ACQUIRE SEWING DATA
S11
N←0
S12
MOVE FIRST GUIDE PORTION TO INITIAL ROTATION ANGLE
S13
MOVE EMBROIDERY FRAME TO ORIGIN
S14
N←N+1
S15
S16
IS ROTATION ANGLE OF N-TH STITCH SAME AS ROTATION ANGLE OF (N - 1)-TH STITCH?
NO
S17
FRAME ROTATION PROCESSING
YES
MOVE EMBROIDERY FRAME TO COORDINATES OF N-TH STITCH
S18
PERFORM SEWING
S19
S20
IS THERE DATA FOR (N + 1)-TH STITCH?
YES
NO
END

FIG. 10

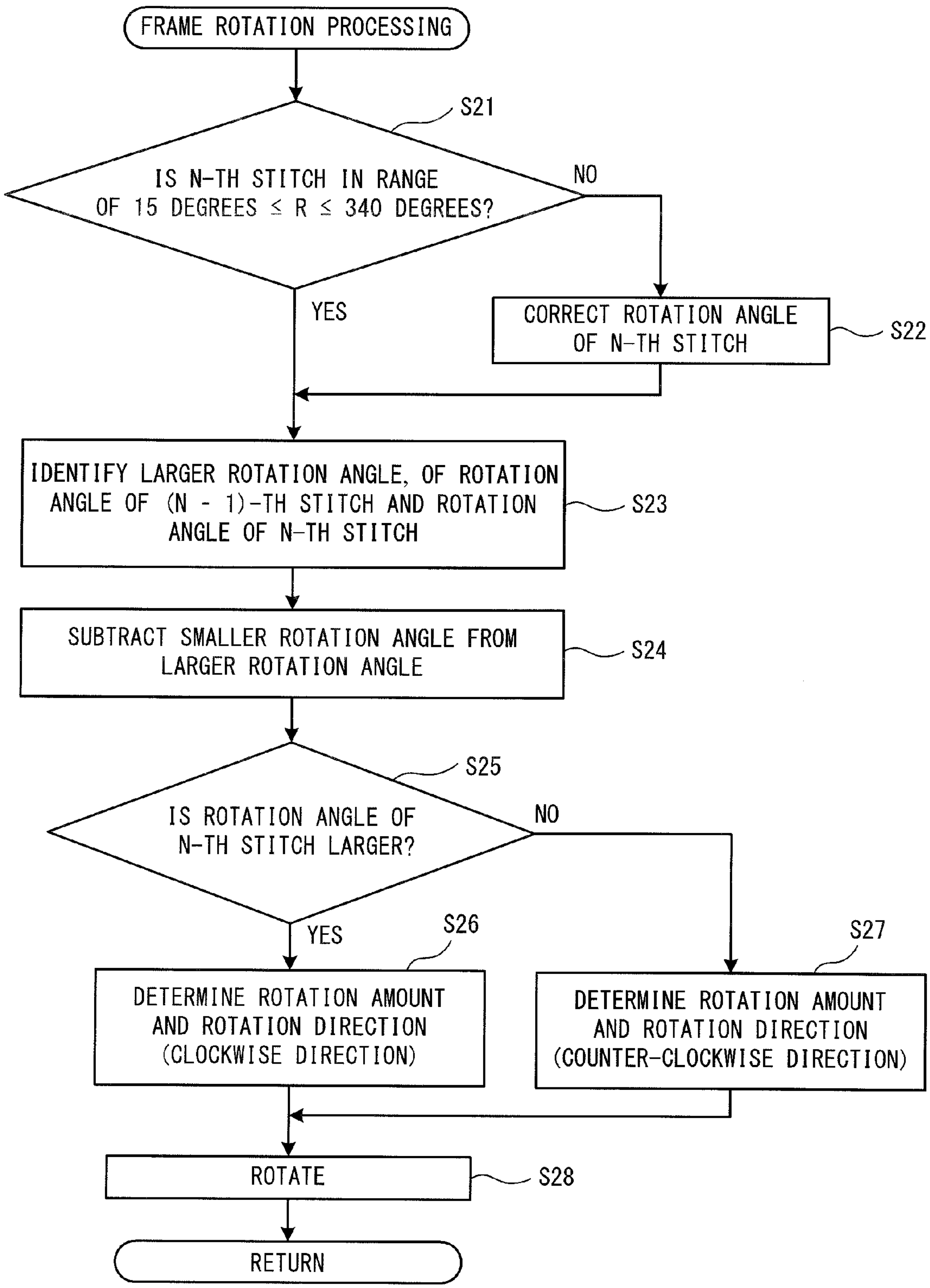
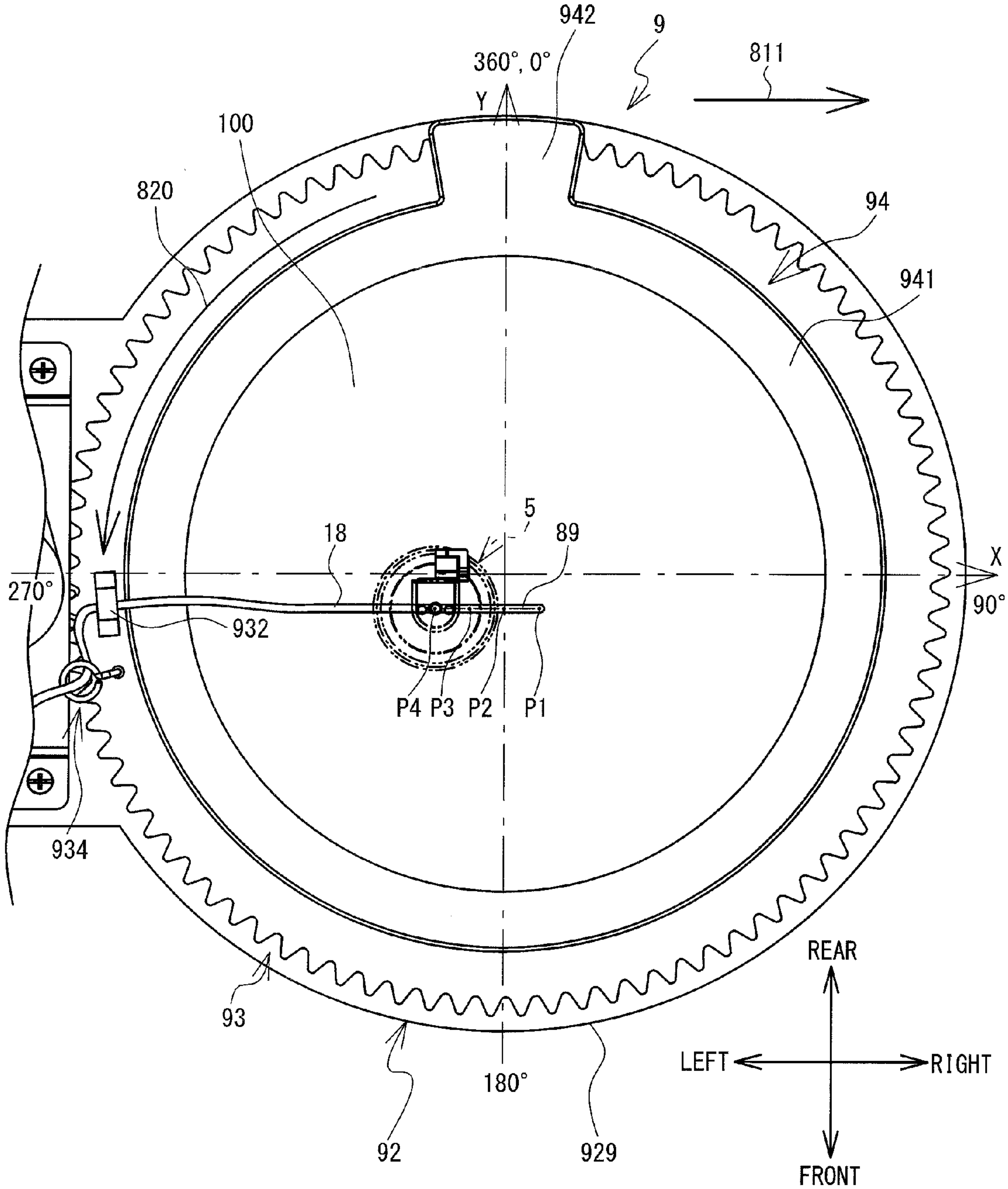

FRAME ROTATION PROCESSING
S21
IS N-TH STITCH IN RANGE OF 15 DEGREES ≤ R ≤ 340 DEGREES?
NO
YES
CORRECT ROTATION ANGLE OF N-TH STITCH
S22
IDENTIFY LARGER ROTATION ANGLE, OF ROTATION ANGLE OF (N - 1)-TH STITCH AND ROTATION ANGLE OF N-TH STITCH
S23
SUBTRACT SMALLER ROTATION ANGLE FROM LARGER ROTATION ANGLE
S24
S25
IS ROTATION ANGLE OF N-TH STITCH LARGER?
NO
YES
S26
S27
DETERMINE ROTATION AMOUNT AND ROTATION DIRECTION (CLOCKWISE DIRECTION)
DETERMINE ROTATION AMOUNT AND ROTATION DIRECTION (COUNTER-CLOCKWISE DIRECTION)
ROTATE
S28
RETURN

FIG. 11



942
9
811
360°, 0°
Y
100
820
94
941
5
18
89
X
270°
932
90°
P4 P3 P2 P1
934
REAR
93
LEFT
RIGHT
180°
92
929
FRONT

FIG. 12

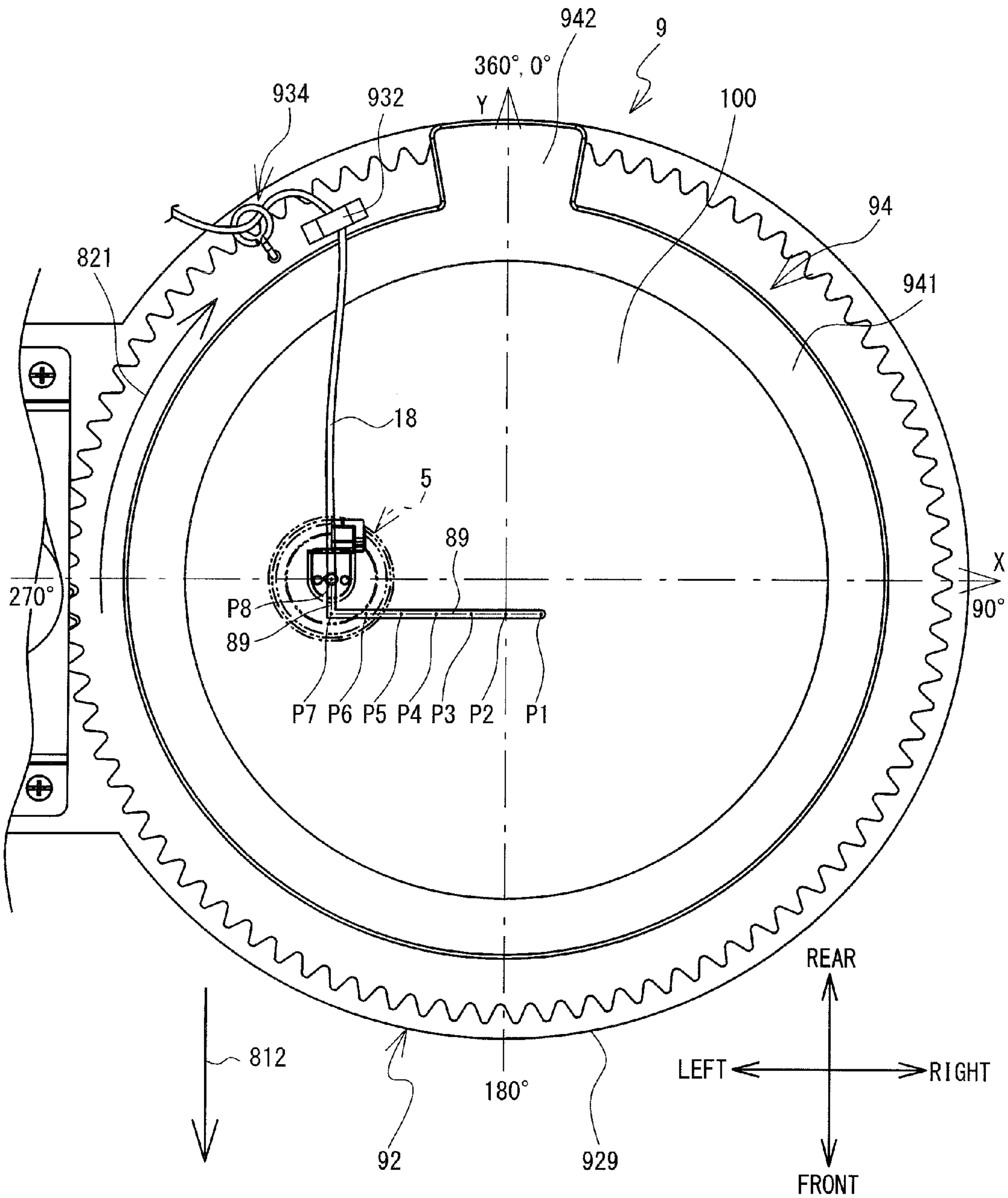
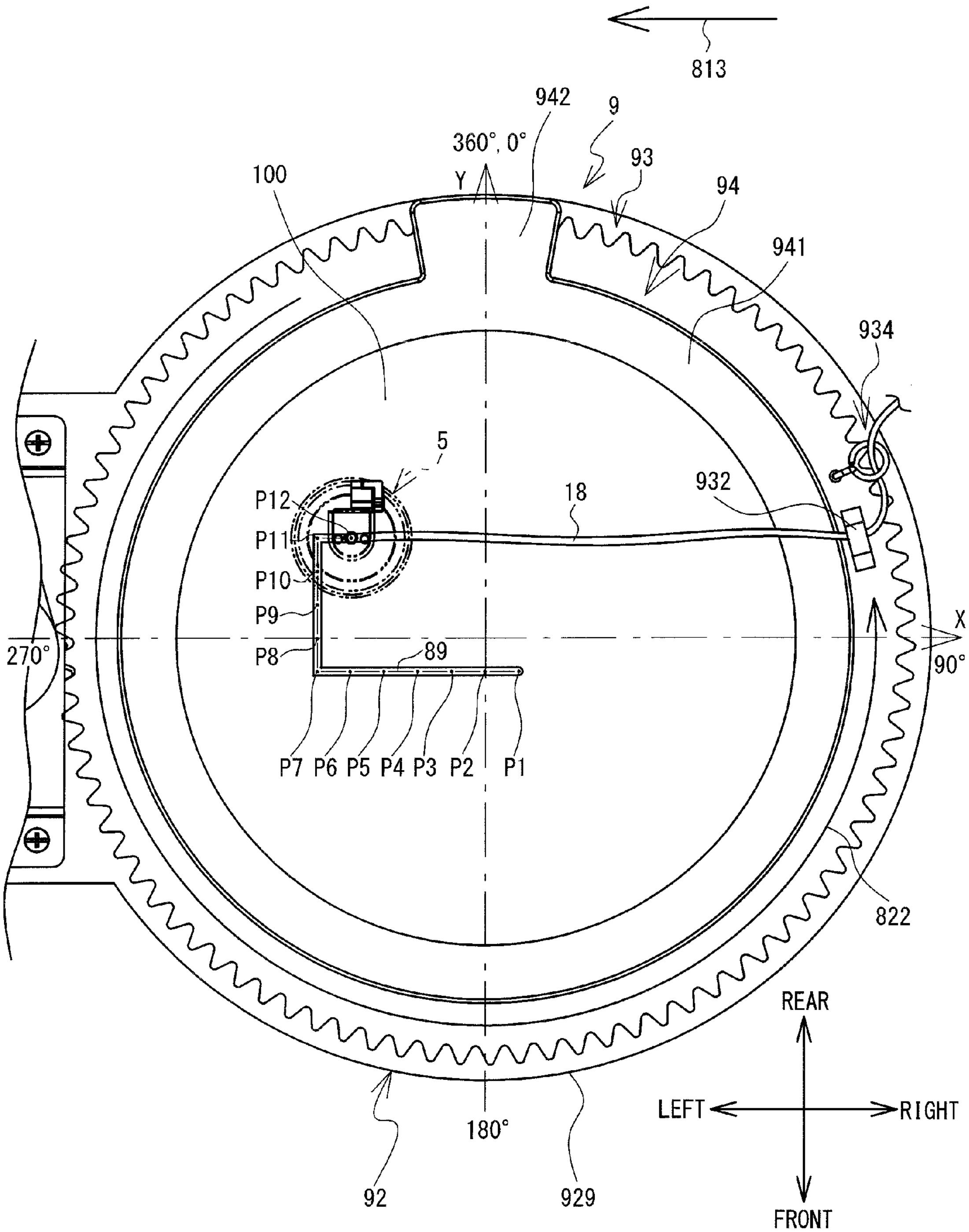

942
9
360°, 0°
Y
934
932
100
94
821
941
18
5
89
X
270°
P8
89
90°
P7 P6 P5 P4 P3 P2 P1
REAR
LEFT
RIGHT
812
180°
FRONT
92
929

FIG. 13



813
942
9
360°, 0°
Y
93
94
100
941
934
5
932
18
P12
P11
P10
P9
270°
P8
89
X
90°
P7 P6 P5 P4 P3 P2 P1
822
REAR
LEFT
RIGHT
FRONT
180°
92
929

FIG. 14

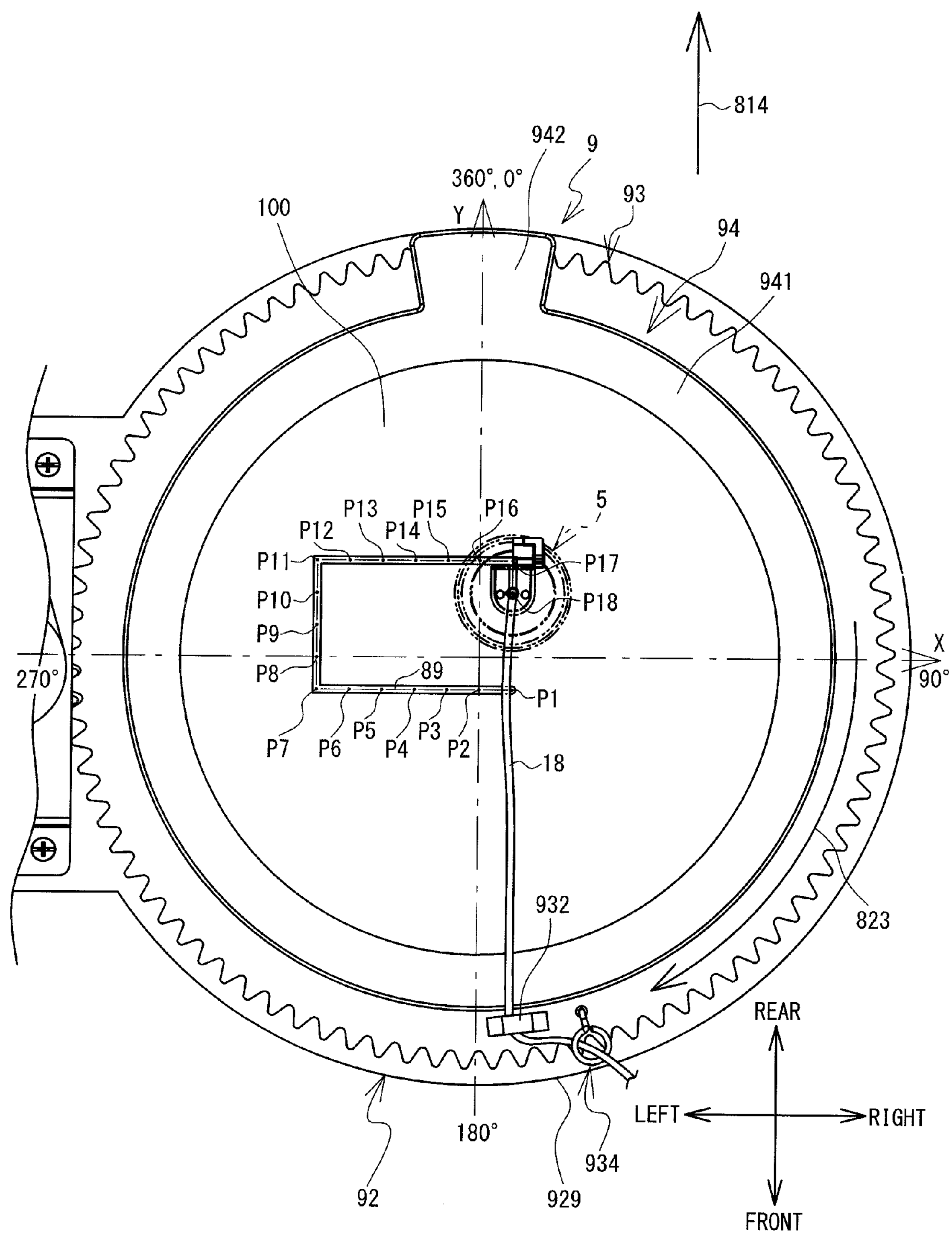
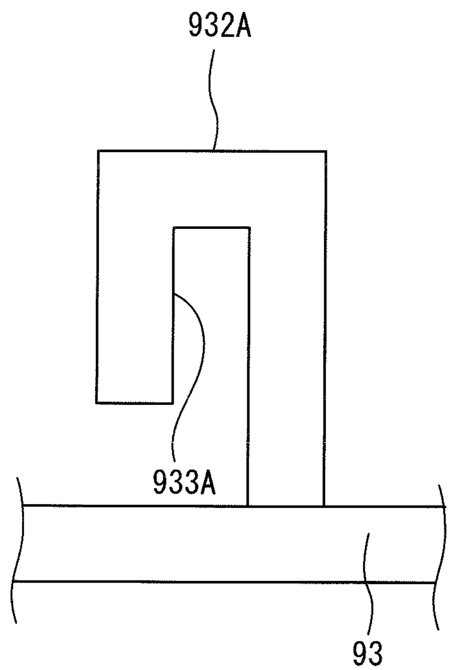

814
942
9
360°, 0°
Y
100
93
94
941
5
P11
P12
P13
P14
P15
P16
P17
P18
P10
P9
P8
270°
X
90°
89
P1
P7
P6
P5
P4
P3
P2
18
932
823
REAR
LEFT
RIGHT
FRONT
180°
92
929
934

FIG. 15



EMBROIDERY FRAME AND SEWING MACHINE

CROSS-REFERENCE TO RELATED APPLICATION

This Application claims priority to Japanese Patent Application No. 2014-033522, filed on Feb. 25, 2014, the content of which is hereby incorporated by reference.

BACKGROUND

The present disclosure relates to an embroidery frame that is mounted on a transport device of a sewing machine, and to a sewing machine that is provided with the embroidery frame.

In related art, an embroidery sewing machine is known that can sew a string-like material onto a work cloth. Wool, a cord, a tape and the like are used as the string-like material. For example, the above-described sewing machine is an embroidery sewing machine that is capable of embroidery sewing, and is provided with a rotation mechanism. The rotation mechanism causes a bobbin, around which is wound the string-like material such as the cord, tape or the like, to rotate centering on a needle bar. The rotation mechanism is driven by a bobbin rotating motor. The sewing machine uses the bobbin rotating motor to rotate the bobbin such that a position of the bobbin is changed, and performs control such that the direction in which the string-like material is supplied is aligned with the direction in which stitches are to be formed.

SUMMARY

Note that the rotation mechanism of the above-described sewing machine is a special mechanism to automatically perform embroidery sewing of the string-like material. Currently, there are sewing machines that are capable of embroidery sewing even among domestic sewing machines that are used in homes by general users. However, it is structurally difficult to provide the above-described rotation mechanism in a domestic sewing machine. Therefore, in order to perform embroidery sewing in which the string-like material is sewn using a domestic sewing machine, a user needs to manually align the direction in which the string-like material is supplied with the direction in which stitches are to be formed.

It is an object of the present disclosure to provide an embroidery frame that makes it possible to automatically perform embroidery sewing to sew a string-like material, particularly in a domestic sewing machine, and a sewing machine that is provided with the embroidery frame.

Exemplary embodiments provide an embroidery frame that includes a mounting portion, an annular portion, a rotation member, a first guide portion, an extending portion, and a drive mechanism. The mounting portion can be mounted on a carriage of a transport device of a sewing machine. The annular portion is formed in an annular shape and is configured to hold a work cloth. The rotation member is formed in an annular shape and is supported by the annular portion. The rotation member can rotate in a circumference direction of the annular portion. The first guide portion is provided on the rotation member and has a first penetrating portion. A through hole is formed in the first penetrating portion. A string-like material to be supplied for sewing is inserted through the first penetrating portion. The extending portion is formed on the annular portion and extends toward the outside in a radial direction of the annular portion. The drive mechanism is provided on the extending portion and rotates the rotation member.

Exemplary embodiments also provide a sewing machine that includes a transport device, a memory, and a control device. The transport device moves an embroidery frame mounted thereon. The embroidery frame includes a mounting portion, an annular portion, a rotation member, a first guide portion, an extending portion, and a drive mechanism. The mounting portion can be mounted on a carriage of the transport device of the sewing machine. The annular portion is formed in an annular shape and is configured to hold a work cloth. The rotation member is formed in an annular shape and is supported by the annular portion. The rotation member can rotate in a circumference direction of the annular portion. The first guide portion is provided on the rotation member and has a first penetrating portion. A through hole is formed in the first penetrating portion. A string-like material to be supplied for sewing is inserted through the first penetrating portion. The extending portion is formed on the annular portion and extends toward the outside in a radial direction of the annular portion. The drive mechanism is provided on the extending portion and rotates the rotation member. The memory stores sewing data to sew the string-like material, the sewing data including movement data that causes the embroidery frame to move for each stitch, and rotation data that causes the rotation member to rotate. The control device acquires the sewing data, and that controls the transport device and the drive mechanism based on the acquired sewing data.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will be described below in detail with reference to the accompanying drawings in which:

FIG. **1** is a perspective view of a sewing machine **1**;

FIG. **2** is a perspective view of an embroidery frame **9**;

FIG. **3** is a plan view showing the embroidery frame **9** that is holding a work cloth **100**, a presser foot **5**, and a path of a string-like material **18**;

FIG. **4** is a side view of the embroidery frame **9**;

FIG. **5** is an exploded perspective view of the embroidery frame **9**;

FIG. **6** is a block diagram showing an electrical configuration of the sewing machine **1**;

FIG. **7** is a data configuration diagram of embroidery data **80**;

FIG. **8** is a view showing an embroidery pattern **200** sewn on the work cloth **100** held by the embroidery frame **9** that has been mounted on a carriage **43**;

FIG. **9** is a flowchart of embroidery sewing processing;

FIG. **10** is a flowchart of frame rotation processing;

FIG. **11** is a view showing a sewing process of the embroidery pattern **200** shown in FIG. **8**;

FIG. **12** is a view showing a sewing process, which is a continuation of FIG. **11**;

FIG. **13** is a view showing a sewing process, which is a continuation of FIG. **12**;

FIG. **14** is a view showing a sewing process, which is a continuation of FIG. **13**; and

FIG. **15** is a view showing a modified example of a first guide portion.

DETAILED DESCRIPTION

Hereinafter, an embodiment of the present disclosure will be explained with reference to the drawings. Note that the drawings are used to explain technical features that the present disclosure can adopt, and the drawings are not intended to limit the content. A physical configuration of a sewing machine **1** will be explained with reference to FIG. **1**.

The up-down direction, the lower right side, the upper left side, the lower left side and the upper right side in FIG. **1** are respectively the up-down direction, the front, the rear, the left and the right of the sewing machine **1**. In other words, the surface on which a liquid crystal display **15** (which will be described later) is disposed is the front surface of the sewing machine **1**. The long side direction of a bed portion **11** and an arm portion **13** is the left-right direction of the sewing machine **1**, and the side on which a pillar **12** is disposed is the right side. The extending direction of the pillar **12** is the up-down direction of the sewing machine **1**.

As shown in FIG. **1**, the sewing machine **1** is a domestic sewing machine that is provided with the bed portion **11**, the pillar **12**, the arm portion **13** and a head portion **14**. The bed portion **11** is a base portion of the sewing machine **1** and extends in the left-right direction. The pillar **12** extends upward from a right end portion of the bed portion **11**. The arm portion **13** extends to the left from the upper end of the pillar **12** such that the arm portion **13** faces the bed portion **11**. The head portion **14** is a portion that is connected to a left end portion of the arm portion **13**.

The bed portion **11** is provided with a needle plate **21** on the top surface of the bed portion **11**. The needle plate **21** has a needle hole (not shown in the drawings). A sewing needle **7**, which will be described later, is inserted through the needle hole. Although none of the following is shown in the drawings, the sewing machine **1** is provided with a feed dog, a feed mechanism, a rotary shuttle and a shuttle drive mechanism etc. below the needle plate **21** (namely, inside the bed portion **11**). During normal sewing, which is not embroidery sewing, the feed dog is driven by the feed mechanism and moves a work cloth, which is a sewing workpiece. The rotary shuttle houses a bobbin around which a lower thread is wound. The shuttle mechanism is rotatably driven by a lower shaft (not shown in the drawings), drives the rotary shuttle, and entwines an upper thread (not shown in the drawings) with the lower thread (not shown in the drawings). The lower shaft is rotatably driven in synchronization with a drive shaft that is rotatably driven by a sewing machine motor **81** that will be described later.

The sewing machine **1** is provided with an embroidery frame transport mechanism (hereinafter referred to as a "transport mechanism") **40**. The transport mechanism **40** can be mounted on and removed from the bed portion **11** of the sewing machine **1**. FIG. **1** shows a state in which the transport mechanism **40** is mounted on the sewing machine **1**. When the transport mechanism **40** is mounted on the sewing machine **1**, the transport mechanism **40** and the sewing machine **1** are electrically connected. The transport mechanism **40** is provided with a main body portion **41** and a movable portion **42**. The movable portion **42** is provided on the upper side of the main body portion **41**. The movable portion **42** has a cuboid shape that is long in the front-rear direction.

The movable portion **42** is provided with a carriage **43**, a Y axis transport mechanism (not shown in the drawings) and a Y axis motor **84** (refer to FIG. **6**). The carriage **43** is provided on the right side surface of the movable portion **42**. A selected one of a plurality of types of embroidery frames can be mounted on the carriage **43**. The embroidery frame of the present embodiment is an embroidery frame **9** that will be described later. Instead of the embroidery frame **9**, an embroidery frame (not shown in the drawings) having a known structure in which a work cloth **100** is clamped and held by an inner frame and an outer frame can be mounted on the transport mechanism **40**. The carriage **43** is provided with a known detector (not shown in the drawings) that detects the type of the embroidery frame mounted on the carriage **43**. For example, a mechanism described in Japanese Laid-Open Patent Publication No. 2002-52283 can be used as the detector.

The work cloth **100** (refer to FIG. **3**) held by the embroidery frame **9** is arranged on the upper side of the needle plate **21** and below a needle bar **6** and a presser foot **5**. The Y axis transport mechanism moves the carriage **43** in the front-rear direction (the Y axis direction). As the carriage **43** is moved in the front-rear direction, the embroidery frame **9** moves the work cloth **100** in the front-rear direction. The Y axis motor **84** drives the Y axis transport mechanism.

The main body portion **41** is internally provided with an X axis transport mechanism (not shown in the drawings) and an X axis motor **83** (refer to FIG. **6**). The X axis transport mechanism moves the movable portion **42** in the left-right direction (the X axis direction). As the movable portion **42** is moved in the left-right direction, the embroidery frame **9** moves the work cloth **100** in the left-right direction. The X axis motor **83** drives the X axis transport mechanism.

The liquid crystal display (hereinafter referred to as the LCD) **15** is provided on the front surface of the pillar **12**. A variety of items, such as commands, illustrations, setting values and messages etc., are displayed on the LCD **15**. A touch panel **26**, which can detect a pressed position, is provided on the front surface side of the LCD **15**. When a user uses a finger or a stylus pen (not shown in the drawings) to perform a pressing operation of the touch panel **26**, the pressed position is detected by the touch panel **26**. Based on the detected pressed position, a CPU **61** (refer to FIG. **6**) of the sewing machine **1** recognizes the item selected on an image. Hereinafter, the pressing operation of the touch panel **26** by the user is referred to as a panel operation. Through the panel operation, the user can select a pattern to be sewn and a command to be executed. The pillar **12** is internally provided with the sewing machine motor **81** (refer to FIG. **6**).

A cover **16** that can open and close is provided on an upper portion of the arm portion **13**. In FIG. **1**, the cover **16** is in a closed state. Although not shown in the drawings, a thread housing portion is provided below the cover **16**, namely, inside the arm portion **13**. The thread housing portion can house a thread spool (not shown in the drawings) around which the upper thread is wound. The drive shaft (not shown in the drawings) that extends in the left-right direction is provided inside the arm portion **13**. The drive shaft is rotatably driven by the sewing machine motor **81** (refer to FIG. **6**). Various switches, including a start/stop switch **29**, are provided on a lower left portion of the front surface of the arm portion **13**. The start/stop switch **29** is used to start or stop operation of the sewing machine **1**, namely, to input a command to start or stop sewing.

A support base **131** is provided on the rear surface of the arm portion **13**. Two support bars **132**, which extend in the up-down direction, are provided on the support base **131** such that the support bars **132** are arranged side by side in the left-right direction. A yarn ball **17** is disposed on the support bar **132** on the left side. For example, the yarn ball **17** is formed by winding wool, which is the string-like material **18**. The string-like material **18** may be a cord, a tape or the like. A guide portion **133** is provided on the rear surface of the head portion **14**. A guide portion **134** is provided on a front portion of the left end of the head portion **14**. The guide portions **133** and **134** guide the string-like material **18** pulled out from the yarn ball **17**. The guide portions **133** and **134** are formed by bending a wire rod, and are fixed to the head portion **14** by screws that are not shown in the drawings.

The head portion **14** is provided with the needle bar **6**, a presser bar (not shown in the drawings), a needle bar up-and-down movement mechanism (not shown in the drawings) and the like. The needle bar **6** and the presser bar extend downward from a lower end portion of the head portion **14**. The sewing needle **7** is detachably mounted on the lower end of the needle bar **6**. The needle bar up-and-down movement mechanism drives the needle bar **6** in the up-down direction by rotation of the drive shaft.

The presser foot **5** is detachably mounted on a lower end portion of the presser bar. The presser foot **5** of the present embodiment is a presser foot that is used to sew the string-like material **18**. As shown in FIG. **3**, the presser foot **5** has a circular disk shape in a plan view, and an end portion on the radially outer side of the presser foot **5** is curved upward. Three hole portions **501**, **502** and **503** that penetrate in the up-down direction are formed in a center portion of the presser foot **5** such that they are arranged side by side in the left-right direction. The sewing needle **7** can be inserted though the center hole portion **502** in the up-down direction. The string-like material **18** that is guided by a first guide portion **932**, which will be described later, is inserted through the center hole portion **502**.

The embroidery frame **9** will be explained with reference to FIG. **2** to FIG. **5**. In the explanation below, the up-down direction of FIG. **2** and FIG. **5** is referred to as the up-down direction of the embroidery frame **9**. As shown in FIG. **2** to FIG. **5**, the embroidery frame **9** is provided with an inner frame **90** and an outer frame **91** (refer to FIG. **5**). The inner frame **90** is provided with a first frame **92**, a second frame **94**, a rotation member **93** and a drive mechanism **98**.

As shown in FIG. **5**, the first frame **92** is provided with an annular frame portion **921**. The outer diameter of the frame portion **921** is smaller than the inner diameter of a frame portion **911** of the outer frame **91**. An outer peripheral side surface of the frame portion **921** is provided with a flange portion **929** that protrudes toward the outside in the radial direction of the frame portion **921**. A part of the frame portion **921** that is located on the upper side (namely, on the second frame **94** side) of the flange portion **929** is referred to as a frame portion **921**A, and a part of the frame portion **921** that is located on the lower side (namely, on the outer frame **91** side) of the flange portion **929** is referred to as a frame portion **921**B (refer to FIG. **4**). The thickness of the frame portion **921**A in an axis line direction (the up-down direction) is slightly larger than the thickness of the rotation member **93** in the axis line direction. The thickness of the frame portion **921**B in the axis line direction is slightly larger than the thickness of the frame portion **911** (to be described later) of the outer frame **91** in the axis line direction (refer to FIG. **4**). As shown in FIG. **4**, when the radially inner side of the frame portion **911** (to be described later) of the outer frame **91** is fitted onto an outer peripheral side surface of the frame portion **921**B of the frame portion **921**, the inner frame **90** and the outer frame **91** are attached to each other.

As shown in FIG. **5**, the first frame **92** is provided with an extending portion **924** that extends toward the outside in the radial direction of the frame portion **921**. The extending portion **924** has a plate shape that has the same thickness as the thickness of the flange portion **929** in the axis line direction, and is formed integrally with the flange portion **929**. On the radially outer side of the frame portion **921**, the leading end of the extending portion **924** is provided with a mounting portion **925**. In other words, the extending portion **924** couples the mounting portion **925** and the frame portion **921**. The mounting portion **925** is configured such that it can be attached to and removed from the carriage **43**.

As shown in FIG. **2** to FIG. **5**, the drive mechanism **98** is provided on the upper side of the extending portion **924**. The drive mechanism **98** rotates the rotation member **93**. As shown in FIG. **5**, the drive mechanism **98** is provided with a gear **981**, a gear **982** and a motor **983**. The outer diameter of the gear **981** is smaller than that of the gear **982**. The gear **981** and the gear **982** are integrally formed. The gear **982** meshes with a frame gear **931** (to be described later) of the rotation member **93**. A shaft (not shown in the drawings) that extends in the axis line direction is inserted through the center of the gears **981** and **982**. An upper end portion of the shaft is axially supported by a hole **988** that extends in the up-down direction and that is provided in an attachment plate **987** (to be described later). A lower end portion of the shaft is axially supported by a hole (not shown in the drawings) that extends in the up-down direction and that is provided in the extending portion **924**. The gears **981** and **982** rotate around the shaft.

The attachment plate **987** has a rectangular shape in a plan view, and is formed such that front and rear end portions of the attachment plate **987** are bent in a crank shape (in a substantial Z shape) in a side view. Four corners of the attachment plate **987** are fixed to the extending portion **924** by screws **985**. The motor **983** is fixed to the top surface of the attachment plate **987** by two screws **986**. The motor **983** is connected, via a cable (not shown in the drawings), to a connector **37** (refer to FIG. **6**) that is provided on the rear surface of the head portion **14** of the sewing machine **1**. The CPU **61** (refer to FIG. **6**) can control the motor **983** via the cable. A drive shaft (not shown in the drawings) of the motor **983** penetrates a hole **989** that extends in the up-down direction and that is provided in the attachment plate **987**, and protrudes below the attachment plate **987**. A drive gear (not shown in the drawings) is anchored to the leading end of the drive shaft. The drive gear meshes with the gear **981**. When a rotation shaft of the motor **983** rotates, the rotation member **93** rotates via the gears **981** and **982**, and the first guide portion **932** and a second guide portion **934** (which will be described later) rotate and move.

As shown in FIG. **5**, the rotation member **93** is an annular plate-shaped member. The inner diameter of the rotation member **93** is slightly larger than the outer shape of the frame portion **921**A of the first frame **92**. Therefore, the rotation member **93** is disposed around the frame portion **921**A while being supported by the flange portion **929**. The outer diameter of the rotation member **93** is smaller than the outer diameter of the flange portion **929**. The frame gear **931** is formed around the entire periphery of an outer peripheral side surface of the rotation member **93**. The frame gear **931** and the gear **982** mesh with each other (refer to FIG. **2**). As shown in FIG. **2** to FIG. **5**, the top surface of the rotation member **93** is provided with the first guide portion **932** and the second guide portion **934**. The first guide portion **932** projects upward from the top surface of the rotation member **93**. The first guide portion **932** is provided with a first through hole **933** that is formed so as to extend in the radial direction of the rotation member **93** (refer to FIG. **2** and FIG. **5**). The first through hole **933** of the first guide portion **932** can guide the string-like material **18** (refer to FIG. **3**).

As shown in FIG. **2** to FIG. **5**, the second guide portion **934** is provided on the counter-clockwise side (in a plan view) of the first guide portion **932** in the circumferential direction of the rotation member **93**. As shown in FIG. **2** and FIG. **5**, the second guide portion **934** is provided with a support column portion **935** and an annular portion **936**. The support column portion **935** and the annular portion **936** are formed by bending a single wire rod. The support column portion **935** extends in the up-down direction. The upper end of the support column portion **935** is bent toward the outside in the radial direction of the rotation member **93**, and the annular portion **936** is formed at the tip of the upper end. The annular portion

936 is provided with a second through hole 937 that penetrates in the up-down direction. The second through hole 937 can guide the string-like material 18 to the first through hole 933 (refer to FIG. 3). The second guide portion 934 is attached to the rotation member 93 by the support column portion 935 being pressed into a hole portion (not shown in the drawings) of a cylindrical portion 938 that protrudes upward from the top surface of the rotation member 93.

As shown in FIG. 5, the second frame 94 is provided with an annular frame portion 941. The frame portion 941 is plate shaped, and a part of an outer peripheral side surface of the frame portion 941 is provided with a protruding portion 942 that protrudes toward the outside in the radial direction. The protruding portion 942 is substantially fan shaped. In a state in which the embroidery frame 9 is mounted on the carriage 43, the protruding portion 942 is in a position where it protrudes rearward. The inner diameter of the frame portion 941 is substantially the same as the inner diameter of the first frame 92. The outer diameter of the frame portion 941 is larger than the inner diameter of the rotation member 93. The second frame 94 is supported by the frame portion 921 of the first frame 92. The second frame 94 is anchored to the upper side of the first frame 92 using, for example, an adhesive. The rotation member 93 is rotatably held in a space that is formed by the second frame 94, the frame portion 941 and the flange portion 929. Positions in the radial direction of the first guide portion 932 and the second guide portion 934 of the rotation member 93 are further to the outside than the outer peripheral side surface of the frame portion 941. Therefore, the first guide portion 932 and the second guide portion 934 can rotate and move without coming into contact with the outer peripheral side surface of the frame portion 941.

As shown in FIG. 5, the outer frame 91 is provided with the annular frame portion 911. The frame portion 911 has a thickness in the axis line direction. As shown in FIG. 4, the outer peripheral side surface of the frame portion 921B of the first frame 92 can be fitted into the inside in the radial direction of the frame portion 911. As shown in FIG. 5, the outer frame 91 is provided with an adjustment portion 915. The adjustment portion 915 can adjust the diameter of the outer frame 91. The diameter of the outer frame 91 is adjusted in accordance with a cloth thickness of the work cloth 100 that is clamped between the outer frame 91 and the first frame 92. The adjustment portion 915 is provided with a divided portion 916, a pair of screw mounting portions 917 and an adjustment screw 918. The divided portion 916 is a portion that is formed such that a part in the circumference direction of the frame portion 911 of the outer frame 91 is divided along the radial direction. The pair of screw mounting portions 917 are provided on both sides of the divided portion 916 of the frame portion 911, and protrude to the outside in the radial direction such that they face each other. The pair of screw mounting portions 917 are provided with hole portions 9171 and 9172 that penetrate in a direction orthogonal to the facing surfaces of the screw mounting portions 917. A nut (not shown in the drawings), in which a screw hole is formed, is embedded in the hole portion 9172 (the hole portion on the upper left side of FIG. 5), of the two hole portions 9171 and 9172.

The adjustment screw 918 is a screw member that has a head portion 9181 with a large diameter, which is rotated by the user pinching it, and a shaft portion 9183 with a small diameter, which extends integrally from the head portion 9181. A male screw portion 9182 is formed on a section of the shaft portion 9183 that is close to the leading end of the shaft portion 9183. Further, a thin groove 9184, into which a retaining ring 9185 is fitted, is formed in a section of the shaft portion 9183 that is close to the head portion 9181. The adjustment screw 918 is mounted such that the shaft portion 9183 penetrates the hole portion 9171 and the male screw portion 9182 is screwed into the screw hole of the nut embedded in the hole portion 9172. In this state, the retaining ring 9185 is fitted into the thin groove 9184 of the shaft portion 9183, and thus the adjustment screw 918 is held by one of the screw mounting portions 917 that has the hole portion 9171, such that the adjustment screw 918 can rotate but cannot move in the axis line direction. Here, when the user pinches the head portion 9181 of the adjustment screw 918 and performs a rotation operation, one of the screw mounting portions 917 that has the hole portion 9172 moves in a direction in which the shaft portion 9183 extends. Further, the movement direction of the screw mounting portion 917 is determined by a rotation direction of the adjustment screw 918. In this manner, the adjustment screw 918 couples the pair of screw mounting portions 917 and also adjusts an interval between the pair of screw mounting portions 917 such that the interval is increased or decreased. As the interval between the pair of screw mounting portions 917 is adjusted, the diameter of the outer frame 91 is adjusted in accordance with the cloth thickness of the work cloth 100. For example, as the interval between the pair of screw mounting portions 917 is widened, the diameter of the outer frame 91 is increased. It is thus possible to clamp the work cloth 100 with a thick cloth thickness between the inner frame 90 and the outer frame 91.

Next, preparations to sew the string-like material 18 using the sewing machine 1 will be explained. First, the user separates the outer frame 91 and the inner frame 90 of the embroidery frame 9, and places the outer frame 91 on a work table (not shown in the drawings). After the user places the work cloth 100 on the upper side of the outer frame 91, the user moves the inner frame 90 downward from above the work cloth 100. As a result, while the lower edge of the frame portion 921B of the first frame 92 is pressing the work cloth 100, the frame portion 921B is inserted into the inside of the frame portion 911 of the outer frame 91. Thus, the work cloth 100 is clamped by the outer peripheral side surface of the frame portion 921B and an inner peripheral side surface of the frame portion 911 (refer to FIG. 4). Then, the user rotates the adjustment screw 918 as appropriate, and adjusts the diameter of the frame portion 911 of the outer frame 91 so that the work cloth 100 does not become displaced. In this manner, in a state in which the work cloth 100 is reliably clamped, a surface of the work cloth 100 on which sewing is performed is appropriately stretched inside of the frame portion 921B at the lower end of the frame portion 921B (refer to FIG. 4).

Next, the user sets the upper thread and the lower thread (which are not shown in the drawings) respectively on the sewing machine 1, and mounts the embroidery frame 9 on the carriage 43, as shown in FIG. 1. Note that an illustration of the work cloth 100 is omitted in FIG. 1. Then, the user pulls out the string-like material 18 from the yarn ball 17 and passes the string-like material 18 through the guide portions 133 and 134. Further, as shown in FIG. 3, the user causes the string-like material 18 to pass through the second through hole 937 of the second guide portion 934 from the upper side to the lower side of the second through hole 937. After that, the user causes the string-like material 18 to pass through the first through hole 933 (refer to FIG. 2) of the first guide portion 932 from the outside to the inside in the radial direction of the rotation member 93. Finally, the user causes the string-like material 18 to pass through the hole portion 502 of the presser foot 5.

An electrical configuration of the sewing machine 1 will be explained with reference to FIG. 6. As shown in FIG. 6, the sewing machine 1 is provided with the CPU 61, and with a

ROM **62**, a RAM **63**, a flash memory **64** and an input-output interface (I/O) **66** that are respectively connected to the CPU **61** by a bus **65**.

The CPU **61** performs main control of the sewing machine **1**, and performs various types of arithmetic operations and processing relating to sewing in accordance with various programs that are stored in the ROM **62**. Although not shown in the drawings, the ROM **62** is provided with a plurality of storage areas including a program storage area and a pattern storage area. Various programs to operate the sewing machine **1** are stored in the program storage area. The stored programs include, for example, a program for the sewing machine **1** to execute embroidery sewing processing (refer to FIG. **9**) that will be described later. Embroidery data to sew various types of patterns is stored in the pattern storage area.

A storage area that stores arithmetic operation results etc. obtained by arithmetic processing by the CPU **61** is provided in the RAM **63** according to need. Various parameters and the like for the sewing machine **1** to execute various types of processing are stored in the flash memory **64**. Drive circuits **71** to **75**, the touch panel **26** and the start/stop switch **29** are connected to the I/O **66**.

The sewing machine motor **81** is connected to the drive circuit **71**. The drive circuit **71** drives the sewing machine motor **81** in accordance with a control signal from the CPU **61**. In accordance with the driving of the sewing machine motor **81**, the needle bar up-and-down movement mechanism (not shown in the drawings) is driven via the drive shaft (not shown in the drawings) of the sewing machine **1**, and the needle bar **6** (refer to FIG. **1**) is moved up and down. The X axis motor **83** is connected to the drive circuit **72**. The Y axis motor **84** is connected to the drive circuit **73**. The drive circuit **75** is connected to the motor **983** of the embroidery frame **9** via the connector **37** and the cable (not shown in the drawings). The drive circuits **72**, **73** and **75** drive the X axis motor **83**, the Y axis motor **84** and the motor **983**, respectively, in accordance with a control signal from the CPU **61**. In accordance with the driving of the X axis motor **83** and the Y axis motor **84**, the embroidery frame **9** is moved in the left-right direction (the X axis direction) and in the front-rear direction (the Y axis direction) by a movement amount corresponding to the control signal. In accordance with the driving of the motor **983**, the rotation member **93** of the embroidery frame **9** is rotated by a rotation amount corresponding to the control signal. The drive circuit **74** drives the LCD **15** in accordance with a control signal from the CPU **61**, and thus causes the LCD **15** to display an image.

Embroidery data **80** of the present embodiment will be explained as one example of embroidery data with reference to FIG. **7**. The embroidery data **80** is data that is used to sew an embroidery pattern **200** (refer to FIG. **8**) such that the string-like material **18** is sewn in a rectangular shape onto the work cloth **100**. The embroidery data **80** is stored in the ROM **62** (refer to FIG. **6**). Note that only a part of the work cloth **100** that is on the inside of the frame portion **921** is illustrated in FIG. **8** and FIG. **11** to FIG. **14**.

As shown in FIG. **7**, the embroidery data **80** includes fields of a number of stitches, an X coordinate, a Y coordinate and a rotation angle, and data that is associated with each of the items is stored. The number of stitches is data that indicates the number (the number of times) that the sewing needle **7** pierces the work cloth **100**, and represents a sewing order. The X coordinate and the Y coordinate are data that indicates coordinates of a position to which the CPU **61** moves the embroidery frame **9** for each stitch. The rotation angle is data that indicates a preset rotation angle by which the rotation member **93** is rotated. The rotation angle is set to an angle at which the first guide portion **932** (refer to FIG. **11**) is arranged. Note that, in the present embodiment, in a state in which the embroidery frame **9** is mounted on the carriage **43**, a center point of the frame portion **921** of the embroidery frame **9** is in a position that matches a needle drop point, and coordinates of this position are defined as an origin (at which the X coordinate is "0" and the Y coordinate is "0"). Note that the needle drop point is a point at which the sewing needle **7** pierces the work cloth and matches a center point of the center hole portion **502** that is formed in the presser foot **5**. Further, it is assumed that coordinates in the left-right direction of the embroidery frame **9** are X coordinates, and coordinates in the front-rear direction of the embroidery frame **9** are Y coordinates (refer to FIG. **8**). Further, the positive direction of the Y axis from the origin is defined as a reference orientation, and a clockwise angle in a plan view is defined as a positive angle (refer to FIG. **8**). In the order from the number of stitches "1" to "21", the position of the first guide portion **932** of the rotation member **93** is matched with the rotation angle in the embroidery data **80**. Then, while the string-like material **18** is being supplied to the sewing needle **7**, the embroidery frame **9** is moved such that the position indicated by the X coordinate and the Y coordinate is positioned at the needle drop point. At the same time, the needle bar **6** (refer to FIG. **1**) is driven and sewing is performed on the work cloth **100**. Thus, as shown in FIG. **8**, the sewing needle **7** pierces positions of points P**1** to P**21**, stitches **89** are formed by the upper thread and the lower thread (not shown in the drawings) along the string-like material **18**, and the string-like material **18** is sewn onto the work cloth **100**.

The embroidery sewing processing will be explained with reference to FIG. **9**. As an example, a case will be explained in which the user selects the embroidery pattern **200** (refer to FIG. **8**) by a panel operation, and inputs a start command to start the embroidery sewing processing. When the CPU **61** detects the input of the start command of the embroidery sewing processing, the CPU **61** reads the program to execute the embroidery sewing processing from the ROM **62** (refer to FIG. **6**) into the RAM **63**, and performs processing of each of steps that will be explained below, in accordance with instructions included in the program. Before inputting the start command, the user mounts the embroidery frame **9** that is holding the work cloth **100** on the carriage **43**.

As shown in FIG. **9**, in the embroidery sewing processing, the CPU **61** first acquires the embroidery data **80** (refer to FIG. **7**) of the embroidery pattern **200** selected at the start of the embroidery sewing processing (step S**11**). More specifically, the CPU **61** acquires the embroidery data **80** from the ROM **62** and stores it in the RAM **63**. Next, the CPU **61** sets a variable N, which indicates a number of the stitches, to **0** and stores it in the RAM **63** (step S**12**).

The CPU **61** moves the first guide portion **932** to an initial rotation angle (step S**13**). The initial rotation angle is an angle at which the first guide portion **932** comes into contact with the left end of the protruding portion **942**. The CPU **61** drives the motor **983** to rotate the rotation member **93** in a clockwise direction in a plan view, and stops the driving of the motor **983** at the position where the first guide portion **932** comes into contact with the left end of the protruding portion **942**. In this manner, the CPU **61** moves the first guide portion **932** to the initial rotation angle. The initial rotation angle is 340 degrees. Next, the CPU **61** moves the carriage **43** by driving the X axis motor **83** and the Y axis motor **84**, and moves the embroidery frame **9** to a position where the origin of the embroidery frame **9** matches the needle drop point (step S**14**).

Next, the CPU **61** increments the variable N and stores it in the RAM **63** (step S**15**). Next, the CPU **61** refers to the embroidery data **80** and determines whether the rotation angle of an N-th stitch is the same as the rotation angle of an (N−1)-th stitch (step S**16**). Note that when the variable N is 1, the rotation angle of a 0-th stitch is the initial rotation angle to which the first guide portion **932** was moved at step S**13**. The initial rotation angle is stored in the ROM **62** in advance. When the rotation angle of the N-th stitch is the same as the rotation angle of the (N−1)-th stitch (yes at step S**16**), the CPU **61** performs step S**18** that will be described later. When the rotation angle of the N-th stitch is not the same as the rotation angle of the (N−1)-th stitch (no at step S**16**), the CPU **61** performs frame rotation processing (step S**17**).

The frame rotation processing will be explained with reference to FIG. **10**. The frame rotation processing is processing that rotates the rotation member **93** of the embroidery frame **9** and changes the rotation angle of the first guide portion **932**. The CPU **61** refers to the embroidery data **80** and determines whether a rotation angle R of the N-th stitch is in a range of 15 degrees≤R≤340 degrees (step S**21**). Note that the angle range that is equal to or more than 15 degrees and equal to or less than 340 degrees is a range in which the first guide portion **932** or the second guide portion **934** can move without being restricted by the protruding portion **942** (refer to FIG. **8**). When the rotation angle R of the N-th stitch is in the range of 15 degrees≤R≤340 degrees (yes at step S**21**), the CPU **61** advances the processing to step S**23** that will be described later. For example, when the variable N=1, the rotation angle of the first stitch is 265 degrees (refer to FIG. **7**). Therefore, the CPU **61** determines that the rotation angle R of the first stitch is in the range of 15 degrees≤R≤340 degrees (yes at step S**21**), and advances the processing to step S**23** that will be described later.

When the rotation angle R of the N-th stitch is in a range of 0 degrees≤R<15 degrees or 340 degrees<R<360 degrees (no at step S**21**), the CPU **61** corrects the rotation angle of the N-th stitch (step S**22**). More specifically, when the rotation angle R of the N-th stitch is in the range of 0 degrees≤R≤15 degrees, the CPU **61** changes the rotation angle of the N-th stitch to 15 degrees. When the rotation angle R of the N-th stitch is in the range of 340 degrees<R<360 degrees, the CPU **61** changes the rotation angle of the N-th stitch to 340 degrees. In other words, the rotation angle is corrected to a range in which the first guide portion **932** or the second guide portion **934** can move without being restricted by the protruding portion **942** (refer to FIG. **8**).

Next, the CPU **61** refers to the embroidery data **80** (refer to FIG. **7**) and identifies, among the rotation angle of the (N−1)-th stitch and the rotation angle of the N-th stitch, a larger rotation angle (step S**23**). Note that, when the value (N−1) is 0, the rotation angle of the 0-th stitch is the initial rotation angle. Next, the CPU **61** subtracts the smaller rotation angle from the larger rotation angle identified at step S**23** (step S**24**). The CPU **61** stores a calculation result in the RAM **63**.

Next, the CPU **61** determines whether the rotation angle of the N-th stitch is larger than the rotation angle of the (N−1)-th stitch (step S**25**). When the rotation angle of the N-th stitch is larger than the rotation angle of the (N−1)-th stitch (yes at step S**25**), the CPU **61** determines the calculation result at step S**24** to be a rotation amount, and determines the rotation direction of the rotation member **93** to be clockwise in a plan view (step S**26**). More specifically, the CPU **61** sets the value of the calculation result at step S**24** as the rotation amount of the embroidery frame **9**. In this case, the rotation amount is a positive value. When the rotation amount is a positive value, the rotation direction of the rotation member **93** is determined to be clockwise in a plan view.

When the rotation angle of the N-th stitch is smaller than the rotation angle of the (N−1)-th stitch (no at step S**25**), the CPU **61** determines the value of the calculation result at step S**24** as a rotation amount of the embroidery frame **9**, and determines the rotation direction of the rotation member **93** to be counter-clockwise in a plan view (step S**27**). More specifically, the CPU **61** determines a value obtained by multiplying the calculation result at step S**24** by "−1" as the rotation amount. In this case, the rotation amount is a negative value. When the rotation amount is a negative value, the rotation direction of the rotation member **93** is counter-clockwise in a plan view. In this manner, when the rotation angle of the N-th stitch is larger than the rotation angle of the (N−1)-th stitch, the rotation direction is determined to be clockwise (step S**26**), and when the rotation angle of the N-th stitch is smaller than the rotation angle of the (N−1)-th stitch, the rotation direction of the rotation member **93** is determined to be counter-clockwise (step S**27**). In this manner, the rotation range R of the first guide portion **932** is restricted to the range of 15 degrees≤R≤340 degrees. In other words, the first guide portion **932** does not pass through a range that is equal to or larger than 0 degrees and less than 15 degrees, and a range that is larger than 340 degrees and less than 360 degrees.

After performing step S**26** or step S**27**, the CPU **61** drives the motor **983** and rotates the rotation member **93** by the rotation amount determined at step S**26** or step S**27** (step S**28**). At this time, the CPU **61** controls the drive mechanism **98** such that the rotation member **93** is rotated in the rotation direction determined at step S**26** or step S**27**. When the rotation amount is a positive value, the CPU **61** rotates the rotation member **93** clockwise in a plan view. When the rotation amount is a negative value, the CPU **61** rotates the rotation member **93** counter-clockwise in a plan view. Note that the work cloth **100** does not move in conjunction with the rotation of the rotation member **93**, and therefore does not rotate.

For example, when the variable N=1, the rotation angle of the first stitch is 265 degrees, and the rotation angle of the 0-th stitch (the initial rotation angle) is 340 degrees. The CPU **61** calculates a value obtained by subtracting 265 degrees, which is the rotation angle of the first stitch, from 340 degrees, which is the rotation angle of the 0-th stitch, thus obtaining 75 degrees (step S**24**). The CPU **61** determines that 265 degrees, which is the rotation angle of the first stitch, is smaller than 340 degrees, which is the rotation angle of the 0-th stitch (the initial rotation angle) (no at step S**25**), and determines that the rotation amount is "−75 degrees" (step S**27**). As shown by an arrow **820** shown in FIG. **11**, the CPU **61** rotates the rotation member **93** counter-clockwise in a plan view by 75 degrees, and rotates and moves the first guide portion **932** (step S**28**). As a result, the first guide portion **932** is arranged at a position of the rotation angle of "265 degrees." The CPU **61** ends the frame rotation processing and returns the processing to the embroidery sewing processing (refer to FIG. **9**).

As shown in FIG. **9**, the CPU **61** moves the carriage **43** by driving the X axis motor **83** and the Y axis motor **84**, and moves the embroidery frame **9** such that the X coordinate and the Y coordinate of the N-th stitch in the embroidery data **80** are located at the needle drop point (step S**18**). The CPU **61** drives the sewing machine motor **81** and sews the N-th stitch (step S**19**). Thus, the N-th stitch is formed and the string-like material **18** is sewn onto the work cloth **100**. For example, when the variable N=1, the CPU **61** moves the embroidery frame **9** such that the X coordinate "1" and the Y coordinate "−1" of the first stitch are located at the needle drop point (step S**18**). Then, the CPU **61** drives the sewing machine motor **81**, drives the needle bar up-and-down movement mechanism and the shuttle mechanism, and sews the first stitch at the point P**1** shown in FIG. **11** (step S**19**).

Next, it is determined whether data of the (N+1)-th stitch exists in the embroidery data **80** (step S**20**). When the data of the (N+1)-th stitch exists (yes at step S**20**), the CPU **61** returns the processing to step S**15**.

For example, in the embroidery data **80** (refer to FIG. **7**), for the number of stitches **1** to **7**, the rotation angle of the first guide portion **932** is 265 degrees. Therefore, when the variable N is 2 to 7, the CPU **61** determines that the rotation angle of the N-th stitch is the same as the rotation angle of the (N−1)-th stitch (yes at step S**16**). The CPU **61** moves the embroidery frame **9** while maintaining the rotation angle of the first guide portion **932** at 265 degrees (step S**18**), and performs sewing at the points P**2** to P**7** (step S**19**). At this time, as shown in FIG. **11**, the CPU **61** moves the embroidery frame **9** to the right as shown by an arrow **811** (step S**18**). The first guide portion **932** is located in a direction opposite to the movement direction (refer to the arrow **811**) of the embroidery frame **9** with respect to the needle drop point. Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction of the embroidery frame **9**.

When the eighth stitch is sewn, the CPU **61** determines that the rotation angle of the eighth stitch is not the same as the rotation angle of the seventh stitch (no at step S**16**), and the CPU **61** performs the frame rotation processing (step S**17**). The rotation angle of the eighth stitch, which is 333 degrees, is larger than the rotation angle of the seventh stitch, which is 265 degrees. Therefore, the CPU **61** determines the rotation amount to be "+68 degrees" (step S**26**). At step S**28**, the CPU **61** rotates the rotation member **93** clockwise by 68 degrees, and thus rotates and moves the first guide portion **932** to the position of 333 degrees (refer to an arrow **821** in FIG. **12**). The string-like material **18** is arranged such that it extends in a direction opposite to the movement direction (refer to an arrow **812**) of the embroidery frame **9** at the eighth stitch. Next, the CPU **61** moves the embroidery frame **9** to the front (refer to the arrow **812**) so that the X coordinate "−5" and the Y coordinate "0" are located at the needle drop point (step S**18**), and sews the eighth stitch at the point P**8** (step S**19**). Thus, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction (refer to the arrow **812**) of the embroidery frame **9**.

In the embroidery data **80** (refer to FIG. **7**), for the number of stitches **8** to **11**, the rotation angle of the first guide portion **932** is 333 degrees. Therefore, when the variable N is 9 to 11, the CPU **61** determines that the rotation angle of the N-th stitch is the same as the rotation angle of the (N−1)-th stitch (yes at step S**16**). The CPU **61** moves the embroidery frame **9** while maintaining the rotation angle of the first guide portion **932** at 333 degrees (step S**18**), and performs sewing at the points P**9** to P**11** (step S**19**). At this time, as shown in FIG. **12**, the CPU **61** moves the embroidery frame **9** to the front as shown by the arrow **812** (step S**18**). The first guide portion **932** is located in a direction opposite to the movement direction (refer to the arrow **812**) of the embroidery frame **9** with respect to the needle drop point. Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction of the embroidery frame **9**.

When the twelfth stitch is sewn, the CPU **61** determines that the rotation angle of the twelfth stitch and the rotation angle of the eleventh stitch are not the same (no at step S**16**), and performs the frame rotation processing (step S**17**). The rotation angle of the twelfth stitch, which is 75 degrees, is smaller than the rotation angle of the eleventh stitch, which is 333 degrees. Therefore, the CPU **61** determines the rotation amount to be "−258 degrees" (step S**27**). At step S**28**, the CPU **61** rotates the rotation member **93** counter-clockwise by 258 degrees, and rotates and moves the first guide portion **932** to a position of 75 degrees (refer to an arrow **822** in FIG. **13**). The string-like material **18** is arranged such that it extends in a direction opposite to the movement direction (refer to an arrow **813**) of the embroidery frame **9** at the twelfth stitch. Next, the CPU **61** moves the embroidery frame **9** to the left (refer to the arrow **813** in FIG. **13**) so that the X coordinate "−4" and the Y coordinate "3" are located at the needle drop point (step S**18**), and sews the twelfth stitch at the point P**12** (step S**19**). Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction (refer to the arrow **813**) of the embroidery frame **9**.

In the embroidery data **80** (refer to FIG. **7**), for the number of stitches **13** to **17**, the rotation angle of the first guide portion **932** is 75 degrees. Therefore, when the variable N is 14 to 17, the CPU **61** determines that the rotation angle of the N-th stitch is the same as the rotation angle of the (N−1)-th stitch (yes at step S**16**). The CPU **61** moves the embroidery frame **9** while maintaining the rotation angle of the first guide portion **932** at 75 degrees (step S**18**), and performs sewing at the points P**14** to P**17** (step S**19**). At this time, as shown in FIG. **13**, the CPU **61** moves the embroidery frame **9** to the left as shown by the arrow **813** (step S**18**). The first guide portion **932** is located in a direction opposite to the movement direction (refer to the arrow **813**) of the embroidery frame **9** with respect to the needle drop point. Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction of the embroidery frame **9**.

In a similar manner, when the eighteenth stitch is sewn, at step S**28**, the CPU **61** rotates the rotation member **93** clockwise by 100 degrees, and rotates and moves the first guide portion **932** to a position of 175 degrees (refer to an arrow **823** in FIG. **14**). Next, the CPU **61** moves the embroidery frame **9** to the rear (refer to an arrow **814** in FIG. **14**) so that the X coordinate "1" and the Y coordinate "2" are located at the needle drop point (step S**18**), and sews the eighteenth stitch at the point P**18** (step S**19**). Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in a direction opposite to the movement direction (refer to the arrow **814**) of the embroidery frame **9**.

The CPU **61** moves the embroidery frame **9** while maintaining the rotation angle of the first guide portion **932** at 175 degrees (step S**18**), and performs sewing at the points P**19** to P**21** (step S**19**). At this time, as shown in FIG. **14**, the CPU **61** moves the embroidery frame **9** to the rear as shown by the arrow **814** (step S**18**). The first guide portion **932** is located in a direction opposite to the movement direction (refer to the arrow **814**) of the embroidery frame **9** with respect to the needle drop point. Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction of the embroidery frame **9**. Thus, the embroidery pattern **200** shown in FIG. **8** is complete. When the sewing is performed up to the twenty-first stitch and it is determined that there is no data for the (N+1)-th stitch (no at step S**20**), the CPU **61** ends the embroidery sewing processing.

The embroidery sewing processing of the present embodiment is performed as described above. The embroidery frame **9** can be mounted on the transport mechanism **40** that is used to perform embroidery sewing using the domestic sewing machine **1**. Therefore, there is no need to provide a special rotation mechanism in the main body of the sewing machine **1** in order to perform embroidery sewing of the string-like material **18**. The sewing machine **1** can hold the work cloth **100** between the frame portion **921** and the frame portion **911**. Further, the first guide portion **932** has the first through hole **933** to guide the string-like material **18**. Therefore, the first guide portion **932** allows the string-like material **18** to pass through the first through hole **933** and thus can guide the string-like material **18** toward the inside of the frame portion **921**. Since the first guide portion **932** is provided on the rotation member **93**, the first guide portion **932** can rotate and move in accordance with the rotation of the rotation member **93**. Therefore, the sewing machine **1** moves the first guide portion **932** by controlling the drive mechanism **98**, and moves the work cloth **100** while changing the direction in which the string-like material **18** is guided toward the inside of the frame portion **921**. At the same time, the sewing machine **1** can automatically perform embroidery sewing such that the string-like material **18** is sewn onto the work cloth **100** on the inside of the frame portion **921**.

Further, the first through hole **933** of the first guide portion **932** is formed so as to extend in the radial direction of the rotation member **93** (refer to FIG. **2**). Therefore, the string-like material **18**, which is guided by being inserted through the first through hole **933**, is guided from the outside toward the inside of the rotation member **93**. It is thus possible to smoothly supply the string-like material **18** from the outside toward the inside of the rotation member **93**.

Further, in addition to the first guide portion **932**, the embroidery frame **9** is provided with the second guide portion **934** that has the second through hole **937**. It is therefore possible to guide the string-like material **18** toward the inside of the frame portion **921** via the second through hole **937** and the first through hole **933**. Thus, in comparison to a case in which the string-like material **18** is guided only by the first guide portion **932**, it is possible to reliably guide the string-like material **18**.

Further, the embroidery frame **9** is provided with the frame gear **931** that is provided on the outer peripheral side surface of the rotation member **93**, the gear **982** that meshes with the frame gear **931**, and the motor **983** that drives the gear **982**. Therefore, by driving the motor **983**, the sewing machine **1** can rotate the rotation member **93**.

Further, the drive mechanism **98** is provided on the extending portion **924** that connects the frame portion **921** and the mounting portion **925**. Here, it is needless to say that the drive mechanism **98** may be provided on a portion other than the extending portion **924**. However, the space to arrange the drive mechanism **98** can be reduced by providing the drive mechanism **98** on the extending portion **924**.

Further, the CPU **61** can control the transport mechanism **40** (refer to FIG. **1**) and the drive mechanism **98** (refer to FIG. **2**) based on the embroidery data **80**. Thus, the string-like material **18** can be sewn onto the work cloth **100**.

When the rotation member **93** is rotated based on the embroidery data **80**, the CPU **61** controls the drive mechanism **98** such that the rotation member **93** is rotated at step S**28** (refer to FIG. **10**) before moving the embroidery frame **9** at step S**18** (refer to FIG. **9**). By doing this, the string-like material **18** is arranged such that it extends in a direction opposite to the movement direction of the embroidery frame **9**. After that, the embroidery frame **9** is moved and the string-like material **18** is sewn (step S**18** and step S**19**). Therefore, the stitches **89** are formed so as to overlap with the string-like material **18** that is arranged such that it extends in the direction opposite to the movement direction of the embroidery frame **9**, and the string-like material **18** is sewn onto the work cloth **100** more reliably.

Further, the CPU **61** can rotate the rotation member **93** in the rotation direction determined at step S**26** or step S**27** based on the embroidery data **80** (step S**28**). For example, in order to avoid the string-like material **18** from becoming wound around the needle bar **6** or the presser foot **5**, it is necessary to set a rotatable range of the rotation member **93**. In the present embodiment, the CPU **61** determines the rotation direction such that the rotation member **93** is rotated within the set rotatable range (step S**26** and step S**27**). It is thus possible to reduce a possibility that the string-like material **18** becomes wound around the needle bar **6** or the presser foot **5**.

Further, in the present embodiment, when the rotation range is a range in which the first guide portion **932** or the second guide portion **934** comes into contact with the protruding portion **942**, namely, when the rotation range is equal to or more than 0 degrees and less than 15 degrees, or more than 340 degrees and less than 360 degrees (no at step S**21**), the rotation angle R is corrected such that it does not fall within the range of 0 degrees≤R<15 degrees and the range of 340 degrees<R<360 degrees (step S**22**). Therefore, even when the rotation angle in the embroidery data **80** is set to a rotation angle at which the protruding portion **942** is located, it is possible to arrange the first guide portion **932** and the second guide portion **934** while avoiding the protruding portion **942**.

Note that the present disclosure is not limited to the above-described embodiment and various modifications are possible. For example, although the first through hole **933** of the first guide portion **932** is a hole, it need not necessarily be a hole as long as it is a penetrating portion that can guide the string-like material **18**. For example, as shown by a first guide portion **932**A in FIG. **15** that is a modified example of the first guide portion **932**, the whole of the first guide portion **932**A may be formed in a hook shape. The up-down direction and the left-right direction of FIG. **15** respectively correspond to the up-down direction and the circumference direction of the rotation member **93**. In the example shown in FIG. **15**, the inside of the hook is a first penetrating portion **933**A that penetrates the first guide portion **932**A. Similarly, the second through hole **937** of the second guide portion **934** need not necessarily be a hole, and may be a penetrating portion that penetrates the second guide portion **934**.

Further, although the first through hole **933** extends to the inside in the radial direction of the rotation member **93**, it may extend in another direction. Although the second through hole **937** extends in the up-down direction, it may extend in another direction. Further, the second guide portion **934** need not necessarily be provided.

The embroidery frame **9** clamps and holds the work cloth **100** such that the outer peripheral side surface of the frame portion **921** is fitted into the inside of the frame portion **911**. However, it is sufficient if the embroidery frame **9** is configured to hold the work cloth **100**, and another configuration may be used to hold the work cloth **100**. For example, a slit to clamp the work cloth **100** may be provided in the bottom surface of a frame portion of the embroidery frame **9**, and the work cloth **100** may be held by the slit. Further, the protruding portion **942** need not necessarily be provided.

Further, although the embroidery data **80** is stored in the ROM **62**, it may be stored in an external storage device of the sewing machine **1**. In this case, the CPU **61** may acquire the embroidery data **80** from the external storage device at step S**11**.

Further, although the rotation direction is determined at step S**26** and step S**27**, the rotation direction need not necessarily be determined and the rotation member **93** may always be rotated clockwise. Further, when the CPU **61** rotates the rotation member **93** based on the embroidery data **80**, the CPU **61** controls the drive mechanism **98** such that the rotation member **93** is rotated at step S**28** (refer to FIG. **10**) before moving the embroidery frame **9** at step S**18** (refer to FIG. **9**). However, the CPU **61** may rotate the rotation member **93** after moving the embroidery frame **9**. Further, the CPU **61** may simultaneously perform an operation to move the embroidery frame **9** and an operation to rotate the rotation member **93**.

What is claimed is:

1. An embroidery frame comprising:

a mounting portion that is capable of being mounted on a carriage of a transport device of a sewing machine;

an annular portion that is formed in an annular shape and that is configured to hold a work cloth;

a rotation member that is formed in an annular shape and that is supported by the annular portion, the rotation member being capable of rotating in a circumference direction of the annular portion;

a first guide portion that is provided on the rotation member and that has a first penetrating portion in which a through hole is formed and through which a string-like material to be supplied for sewing is inserted;

an extending portion that is formed on the annular portion and that extends toward the outside in a radial direction of the annular portion; and

a drive mechanism that is provided on the extending portion and that rotates the rotation member.

2. The embroidery frame according to claim **1**, wherein

a direction of penetration of the first penetrating portion penetrates is along a radial direction of the rotation member.

3. The embroidery frame according to claim **2**, further comprising:

a second guide portion that has a second penetrating portion that is provided on the rotation member,

wherein

the second penetrating portion is open along a rotation axis direction of the rotation member, and is provided on an upstream side of the first penetrating portion on a feed path of the string-like material, the string-like material to be supplied for sewing being inserted through the second penetrating portion.

4. The embroidery frame according to claim **3**, wherein

the first penetrating portion and the second penetrating portion are holes.

5. The embroidery frame according to claim **1**, wherein

the rotation member includes a first gear on an outer peripheral side surface of the rotation member, and

the rotation mechanism includes a second gear that meshes with the first gear, and a motor that drives the second gear.

6. The embroidery frame according to claim **1**, wherein

the annular portion includes a first annular portion having an annular shape, and a second annular portion having an annular shape, which is configured such that an outer peripheral side surface of the first annular portion is fitted into the inside of the second annular portion.

7. A sewing machine comprising:

a transport device that moves an embroidery frame mounted thereon, the embroidery frame including

a mounting portion that is capable of being mounted on a carriage of the transport device of the sewing machine,

an annular portion that is formed in an annular shape and that is configured to hold a work cloth,

a rotation member that is formed in an annular shape and that is supported by the annular portion, the rotation member being capable of rotating in a circumference direction of the annular portion,

a first guide portion that is provided on the rotation member and that has a first penetrating portion in which a through hole is formed and through which a string-like material to be supplied for sewing is inserted,

an extending portion that is formed on the annular portion and that extends toward the outside in a radial direction of the annular portion, and

a drive mechanism that is provided on the extending portion and that rotates the rotation member;

a memory that stores sewing data to sew the string-like material, the sewing data including movement data that causes the embroidery frame to move for each stitch, and rotation data that causes the rotation member to rotate; and

a control device that acquires the sewing data, and that controls the transport device and the drive mechanism based on the acquired sewing data.

8. The sewing machine according to claim **7**, wherein

when the rotation member is rotated based on the sewing data, the control device controls the drive mechanism such that the rotation member is rotated before the embroidery frame is moved.

9. The sewing machine according to claim **7**, wherein

the control device determines a rotation direction of the rotation member based on the sewing data, and

the control device controls the drive mechanism such that the rotation member is rotated in the determined rotation direction.

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